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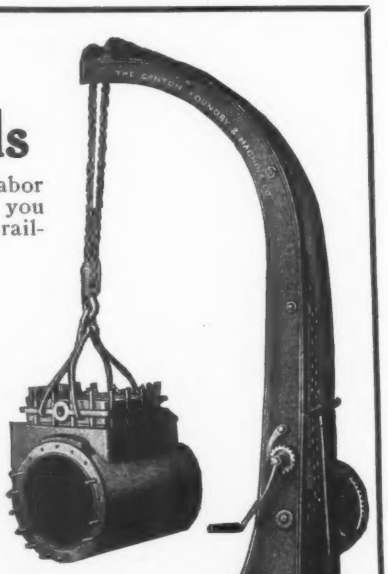


Railway Mechanical Engineer

Volume 90 August, 1916 No. 8

The Future of the Brick Arch

Anything that compels an increase in the amount of heat absorbed by the heating surfaces in the boiler is bound to improve the efficiency of operation of the locomotive. What the railroads need is more drawbar horsepower for each pound of coal burned on the grates. The development of the brick arch during the past ten years has made it a prominent factor in attaining the present locomotive power output. It has done this by producing more complete combustion and compelling the boiler to absorb a greater proportion of the heat units liberated in the firebox. But a good many railway men seem to think that in the present development of the arch it has practically reached its limitations as regards increasing locomotive capacity. It does not seem that there will be any such limitation. There have been many devices brought out in the past which seemed at one time or another to have reached the highest point of their development but within a few years they have been subjected to changes and improvements which have resulted in still further increasing their efficiency. The brick arch is being given the constant attention of experts. It is being developed and improved whenever such improvements seem necessary or desirable and it is believed that the next few years will see still further increases in locomotive capacity and economy due to its use.

Do Your Locomotives Suit Operating Conditions?

When an electrical engineer designs a motor he first familiarizes himself with the work which is expected of the completed machine. He knows the characteristics of electric motors and can determine from the curves which show these characteristics the size of the motor necessary and at what speed and output it is necessary for it to work. He would not think of putting a 90 h.p. motor on work that required only an average output of 60 h.p. It would be quite apparent that the motor would not operate at nearly its maximum efficiency under such conditions. The steam locomotive has just as well defined characteristics as the electric motor. It is quite possible to make a study of the operating conditions affecting the movement of trains on various parts of a railroad and by a careful analysis of them to determine the locomotive characteristics which will most satisfactorily and economically meet the conditions. The carrying out of such analyses preliminary to determining on a design of locomotive to give the best operating results is only a matter of common engineering sense; and yet how little the railroads seem to be following this practice in deciding on new locomotives. It is surely apparent to any railway man, whether or not he is a mechanical department man, that a locomotive which will operate the maximum time at its maximum economy is doing a great deal more toward increasing the company's net revenue than one which is developing only a portion of the power of which it is capable and working at a rate which is not that of greatest economy. Locomotives should be designed to meet the conditions under which they are to operate, just as much as any other form of machine. The Pennsylvania Railroad has followed a policy of this kind until the resultant reduction in operating expenses is plainly in evidence in the figures shown in its annual report. There is no reason why other railways cannot improve their operating results by the application of engineering principles to determine the character of the locomotives which they need, and in most cases there is every reason why they should follow such a practice.

Hot Boxes on Freight Cars

For years hot boxes under freight cars have proved to be one of the most troublesome problems confronting the car department. In spite of the changes in design and the greater attention which is given to lubrication and maintenance, as well as inspection, hot boxes still persist and are almost as great a problem today as they were many years ago. With the increase in severity of operating conditions, still greater efforts must be made if this difficulty is to be entirely overcome; and it is advisable that it should be, because of the great expense and inconvenience caused by delay to trains, interference with schedules, etc., in addition to the increased cost of maintenance. Many minds have been at work upon this problem and expert investigations have been made by a large number of railroads. In order to round up the ways in which hot boxes on freight cars may be overcome, we should like to hear from those who have given this subject special attention and study. To this end we offer three prizes of $15 each for the best letters, not to exceed 750 words in length and accompanied by sketches or photographs where necessary, which are received at our offices in the Woolworth building, New York, not later than October 1. The judges will base their decision entirely upon the practical value of the suggestions which are made. Letters which are not awarded a prize, but which are published, will be paid for at our regular rates.

Steel Gondola Cars with Wooden Sides

A substitute for the all-steel gondola car that has been found to be very satisfactory is a car that is made of steel with the exception of the floor and sides, which are built of wood. In these parts of the all-steel gondola the metal is thinner than that used in any other part of the car, and it is subjected to much more abuse and corrosion. It is practically impossible to keep the inside of these cars properly protected with paint, with the result that whether the cars are working or idle, corrosion takes place and gets in its worst work when the cars are idle. The wooden floors and sides offer many advantages. The troubles due to corrosion are eliminated and repairs can be made much more easily. A hole in a steel sheet means a riveted patch or the expensive removal and application of an entirely new sheet. Where wood is used the defective boards are easily removed and new ones applied. The wood will also stand up under shocks without deformation where the steel sheet will be bent, necessitating the use of oil torches and hammers, and sometimes presses, to bring them back into shape. By

the use of wood in these parts the strength of the car need not be diminished and the car, except in the case of hot loads, can be used in the same service as the all-steel gondola. Many roads are following this practice in replacing this class of equipment, as well as in cases where additional equipment is purchased. Their experience with this class of cars has been very satisfactory.

Triplex Articulated Locomotives

While the Erie Railroad is the only one that has gone into the use of the Triplex articulated compound locomotive, the officers have found the locomotive of this type which was placed in service in 1914 on Susquehanna Hill so satisfactory that two additional locomotives of the same wheel and cylinder arrangement have recently been added to the road's equipment. It is of interest to note that the changes from the original design have been very few. Practically all of the machinery and structural details are the same in the three locomotives. The principal change has been in the grate area. The original locomotive was constructed with the Gaines wall in the firebox and the need of a larger grate area prompted the omission of this wall in the new engines, increasing the grate area from 90 sq. ft. to 121.5 sq. ft., the brick arch being retained in the latest engines. The effect of this increase in grate area may be judged by a comparison of some of the ratios. There is very little change in the ratio of firebox to total heating surface, but the ratio of total (equivalent) heating surface to grate area in the original design is 102.9, while in the new engines it is 75.9, indicating either that the fuel will be burned at a considerably lower rate of combustion in the new engines, or that the same rate of combustion will be more effective in steam generation. The ratio of grate area to volume of the equivalent simple cylinders in the original engine is 1.75 and in the new ones it is 2.4. Considerable skepticism was apparent in railway circles when the first of these locomotives was built, but it is evident from the purchase of the two additional ones that the original design has amply justified itself in the eyes of the officers of the Erie.

The Mechanical Department Supply Manufacturer

At the beginning of 1913 this journal started the practice of grouping in a separate department the descriptions of new devices, which had been perfected and placed on the market by railway supply manufacturers. Some of our friends smiled and prophesied the early discontinuance of this section because of the lack of sufficient material to justify the use of the special heading. To be described in this section a device must have proved practical and must not have been previously described in this publication. An important improvement in an old or standard device is classed as a new device. The measuring stick applied to each device is its practical value and interest to the reader; whether the manufacturer is an advertiser, prospective advertiser or a non-advertiser is not considered. The department proved to be a success from the very start. During the past 12 months (August, 1915-July, 1916), for instance, we used 60 pages, or an average of 5 pages in each number, to describe 98 devices, classified as follows: Car, 22; locomotive, 24; shop equipment, 45; and miscellaneous, 7. In addition to this the June Daily issues of the Railway Age Gazette, which are furnished to subscribers of the *Railway Mechanical Engineer*, contained 32 pages in which 67 new devices were described, classified as follows: Car, 34; locomotive, 13; shop equipment, 19; and miscellaneous, 1. A new device to be described in the Daily must fulfill the conditions outlined above; it must not have been described in the *Railway Mechanical Engineer*, and it must be on exhibition at the conventions. Within a period of 12 months, therefore, we have published a total of 92 pages containing descriptions of 165 different new devices. This truly remarkable record is a good barometer of the progressiveness of the mechanical department railway supply manufacturer.

Standard Shop Tools

During the past ten years the average daily wage for machinists has increased on an average of 2½ per cent per year, until now the total amount paid for this class of labor by the railways of this country exceeds $60,-000,000. The percentage increase for the year will be much larger than in previous years due to the demand for machinist labor by the munitions manufacturers. It behooves mechanical department officers, therefore, to devise some means by which this large and growing increase may be offset. An important item that immediately comes to mind is the increase in shop efficiency. This can be realized to a considerable degree by the standardization of shop tools. The time it takes a machinist, or any other workman for that matter, to do a piece of work depends, to a very large extent, on the efficiency of the tool with which he is doing the work.

Each tool has a certain contour, rake, clearance, size of shank, etc., that will give the best results for each class of work to be done. Dimensions for lathe tools and drills especially should be carefully determined, and such tools all over the road should be maintained according to the standards established. Where the workmen are allowed to grind their own tools there is certain to be a wide variation from the standard with an accompanying decrease in the efficiency of the tool which goes hand in hand with poor work and small shop output. After standards have once been established the only means by which they can be maintained is to have all the tools made, repaired and sharpened under the direction of one man—the tool foreman. He should be held responsible for the condition of the tools in his shop and should be given every assistance in keeping them up to standard. With his special grinders, gages and facilities for properly forming the tools, and the specialists he may have in his department, the tools can be kept in the proper form for maximum efficiency.

An interesting case where standard beading tools would have saved many leaky tubes and some engine failures was found on one road in the West. The water conditions were not of the best and it was found necessary to do a little beading on the tubes at the end of each run. The tube leakage on the engines in question got worse instead of better, and investigation showed that the boiler makers at one end of the division used a beading tool of different contour from that used at the other end. Each time the tubes were beaded the metal was wasted away, making the conditions worse every time, until the tubes had to be removed without making anywhere near their proper mileage. By establishing standards for these two terminals this trouble was overcome.

High Capacity and Low Axle Weight

Locomotives of the 2-10-2 type recently built for the Texas & Pacific by the Baldwin Locomotive Works are of unusual interest because of the power developed, while at the same time the driving axle loads are kept at 52,400 lb. A description of these locomotives will be published in a later issue, but a brief analysis of some of their characteristics should prove interesting. The engines have 28 in. by 32 in. cylinders, 63 in. diameter drivers, 185 lb. boiler pressure, and a total evaporative heating surface of 3,846 sq. ft., of which 307 sq. ft. is in the firebox and 3,539 sq. ft. in the tubes. At 1,000 ft. per minute piston speed they are capable of developing 2,600 indicated horsepower. Their total weight is 324,600 lb. and the weight on drivers 292,100 lb. The New York, Ontario & Western locomotives of the same type are capable of developing an indicated horsepower of 2,700 at the same piston speed, but they

have a total weight of 352,500 lb. and a weight on drivers of 293,000 lb., which is 58,600 lb. per axle. The Texas & Pacific locomotives will produce one indicated horsepower for each 12.5 lb. of total weight, while the New York, Ontario & Western engines will produce a horsepower for each 13.1 lb. The Texas & Pacific engines have to develop .676 horsepower for each square foot of evaporative heating surface while this figure in the New York, Ontario & Western engine is .601, but as the Texas & Pacific engines burn oil they undoubtedly have ample evaporative capacity.

These engines were built for operation on 70-lb. rails and in order to provide the power desired it was necessary to go to the 2-10-2 arrangement or else exceed the safe axle loads. It is also of interest to note that the Delaware & Hudson pulverized fuel burning Consolidation will produce 2,550 indicated horsepower at 1,000 ft. piston speed per minute. While, of course, in this case the weight per driving axle is high, the fact that this engine will develop one horsepower for each 11.5 lb. of total weight is an indication of what can be done in the way of boiler capacity without going to the use of a trailing truck. That the Delaware & Hudson engine has the capacity to meet this horsepower output is indicated by a comparison of the figures for the heating surface with those for the Texas & Pacific engine. The firebox heating surface in the Delaware & Hudson engine is 305 sq. ft., the tube heating surface 3,509 sq. ft. and the total evaporative heating surface 3,814 sq. ft. The weight of the Delaware & Hudson engine on drivers is 267,500 lb. and the total weight 293,000 lb., and the figure of 11.5 lb. total weight per indicated horsepower compares with a corresponding figure of 11.8 lb. for the latest 2-10-2 type engines used on the Erie Railroad, which have a total engine weight of 401,000 lb. and a weight on drivers of 335,500 lb.

Mechanical Conventions in August and September

The Master Mechanics' Association as a body has recognized the importance of the "other" railway mechanical associations by the formation of a committee to co-operate with these associations, and at the June convention this committee presented a report in which was included contributions from the Association of Railway Electrical Engineers, the Traveling Engineers' Association, the General Foremen's Association and the Tool Foremen's Association. The last three mentioned associations, together with the Master Blacksmiths' Association, will meet within the next few weeks, and it is strongly urged that the mechanical department officers give their earnest consideration to the matter of sending to these conventions their foremen who are directly interested in work of the respective associations. All four of these associations are well established organizations, and, as past results have shown, contribute materially to economical shop production.

There are three important reasons why these men should attend the conventions in which they are particularly interested. Perhaps the most important one is the broadening of their knowledge by the important ideas picked up in their informal talks with fellow craftsmen on problems that they are perhaps having difficulty in solving. The next is the information they receive in listening to the results of a committee's work on a certain subject and the discussion which follows. Here is where they can perform a dual service—absorb all the information they can from fellow members and give those same members the benefit of their personal experience. It is only by such reciprocity that the most can be learned from any subject discussed.

The supply men's exhibit is also of great importance. It is well known that most of the economies effected in locomotive or shop operation are the results of the machines or devices sold or controlled by the railway supply firms. These companies, specialists in their respective lines, spend large sums of money in studying and developing their products and come to these conventions well prepared to show the railway men on the firing line just what their devices will do. With their apparatus set up in the exhibition hall they can explain clearly the details of the various devices, show the men what they are expected to do, how it is done and how they should be maintained in order that the best results may be obtained from their use. It is important that these men should know all about these new devices. Take the traveling engineer, for instance; he is called upon to instruct the men regarding the use of more different devices and make reports to his superior officer regarding them than perhaps any other man on the railroad. If he is to do this intelligently he must see the devices in the form of models and be thoroughly posted on their operation and special features. It is much more satisfactory both to him and the manufacturer to have these devices explained from working models cut open or taken apart for the purpose, than from the finished devices which are perhaps located on some inaccessible part of the locomotive. The shop foremen can be shown how to get the most work out of the tools they may have, or they may find a new device that will prove to be of decided advantage in their particular line. The exhibits are an important part of any convention, and the supply men's associations aim to make them complete and educational in nature. Last year there were 72 exhibitors at the Traveling Engineers' convention, 40 at the General Foremen's convention and 32 at the Tool Foremen's convention. This year it is confidently expected that there will be an increase in these numbers.

The lists of subjects to be discussed at these conventions have been published in the *Railway Mechanical Engineer* and are again included in this number; it will be noticed that they are all of importance in the fields of the respective associations. New problems are constantly arising in the railway mechanical department, and these associations have done much to overcome them. The men should be sent to the conventions to give and receive all the information possible. On some roads it is the practice for the men attending to submit written reports to their superiors of the important things learned from both the discussions of the committee reports in the convention hall and from a study of the exhibits shown in connection with the convention. This is a splendid plan to follow, for it not only firmly fixes the benefits obtained from the convention in their own minds, but also gives the men at home the benefit of the attendant's experience.

NEW BOOKS

National Association of Corporation Schools. Report of the third annual convention. Bound in cloth, 880 pages, 6 in. by 9 in. Published by the Association, Irving Place and 15th street, New York.

This volume contains the papers, reports, bibliographies and discussions of the third annual convention, held in Worcester, Mass., June 11, 1915. A number of charts are used and the subjects considered include public education, trade apprenticeship schools, vocational guidance, special apprenticeship schools and satisfactory hygiene and co-operation.

Inventions and Patents. By Philip E. Edelman. Bound in cloth, 279 pages (including an appendix), 5 in. by 8 in. Illustrated. Published by D. Van Nostrand Company, 25 Park Place, New York. Price $1.50.

This volume is intended for all persons who are interested in patents either as inventors, investigators or manufacturers. There seems to be a general ignorance among such men of the points involved in patent procedure and the possibilities in patented inventions. The subject is explained in this book in every-day terms. The matter is intended to be suggestive and there are no set rules to be applied in every case. The book is not intended to be exhaustive, as the author considers the subject too comprehensive to allow of such treatment. The information given will be found reasonably complete and all that is necessary in most cases. The viewpoint is optimistic throughout and considers the interests of all concerned.

COMMUNICATIONS

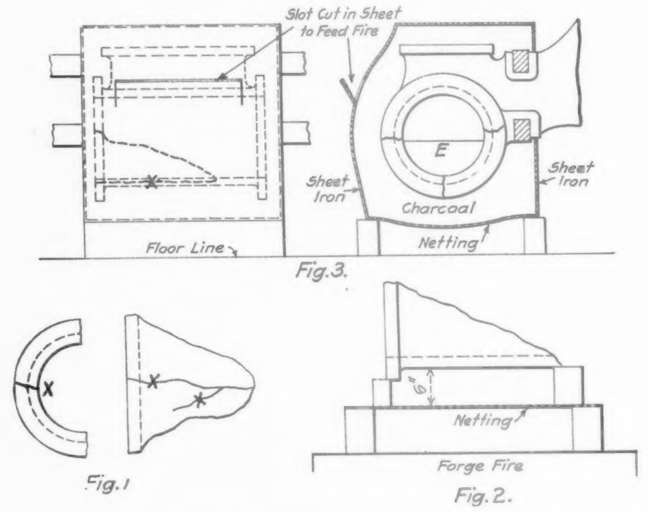
OXY-ACETYLENE CYLINDER WELD

KANSAS CITY, MO.

TO THE EDITOR:

Since the publication of the article on "A Record Cylinder Weld" in the *Railway Mechanical Engineer* for April, page 199, Mr. Foster, master mechanic of the St. Louis & San Francisco at Kansas City, who sent you the information, has received a number of inquiries as to the methods followed in making this weld, the kind of flux used, whether or not the weld was easily machined and numerous others. As this cylinder is similar to three others recently repaired, as the same general method was followed, and as the finished jobs were excellent, I believe we can perhaps assist others who are contemplating cylinder welding by going into more detail on this particular job.

The most essential part in work of this kind is to have two welding operators who have had thorough experience on welding cast iron and other metals by the oxy-acetylene method and who can be relied upon to follow instructions closely even to the smallest item, which sometimes may be the most important. For work of this character acetylene operators, no matter how proficient they may be, who have not been accustomed to perform tasks when extreme heat is encountered should not be selected or failure will result. With operators who are accustomed to heat, work of this kind is not laborious nor unpleasant. While no two jobs of this kind are exactly alike, it being necessary to prepare and handle them differently so as to make it more convenient for the operators and to prevent checks in the finished job, the same rules will apply generally. The expansion and contraction of the metals, a clear understanding as to the shape of the article welded and the proper part to heat first and last to prevent failure, should be thoroughly fixed in the minds of the operators before beginning. The kind of flux used is not of so much importance as the proper amount to be used and the manner of applying it. This applies also to the use of a welding flux at the forge. In either case it requires some little experience. On this weld Ferro flux was used and the cylinder was bored with as much ease as any ordinary cast iron.



Oxy-Acetylene Cylinder Weld. Fig. 1—Broken Parts of the Cylinder Welded Before Placing on the Engine; Fig. 2—Manner of Placing the Parts (Fig. 1) on the Forge Fire; Fig. 3—Method of Heating the Entire Cylinder Preparatory to Welding

Fig. 1 shows the parts that were taken to the smithshop. The surfaces to be welded were V'd out by chipping and the parts clamped together at the proper radius. They were then placed on blocks above a forge fire, as shown in Fig. 2, and brought to a red heat. They were then welded along the lines marked "X" in Fig. 1. The welded segment was then covered with sheet iron or asbestos with a charcoal filling and allowed to cool slowly. It is very important not to allow cold blasts to blow on the metal while it is hot. When it was cool it was fitted to the cylinder and the cracks to be welded were chipped out from the inside. No chipping was done on the segment except at the extreme point of the break, which was done to give the operators a better opportunity to make the weld and to prevent the metal flowing off. After clamping the segment in place a temporary furnace was constructed by placing pieces of coarse netting, about 4 ft. by 5 ft., on top of spring bands or blocks about 7 in. from the floor. The cylinder was then surrounded by a sheet iron or heavy tin shell, as shown in Fig. 3, the different pieces being wired together to completely enclose the cylinder. A slit was cut in the outside wall and bent out to form a hopper through which was fed the charcoal for heating the lower part of the cylinder. A coal oil torch was used to heat the heavy parts of the cylinder on the top and side next to the frame. The cylinder was heated gradually and care was taken not to suddenly heat one part of the cylinder while the rest was cold. When the cylinder was at a red heat two operators, one on each end, started welding while a laborer watched the fire and also kept all doors closed through which there might be a draft blowing on the cylinder. After the welding had been completed on the inside the ends or flanges were welded from the outside and the corners were built up. A piece of wire screen was then placed at *E* in the cylinder a little below the center, on which hot charcoal was placed. It was then filled with more charcoal and both ends of the cylinder were securely closed with sheet iron, the fire allowed to burn out and the cylinder was left to cool slowly. The metal on this cylinder was 2⅛ in. thick, while on other engines on which similar work was done the thickness was 1⅝ in. and ⅞ in. In the case of the latter, however, it was necessary to put a bushing in the cylinder.

M. C. WHELAN,

Foreman Blacksmith, St. Louis & San Francisco.

GREASE LUBRICATION OF LOCOMOTIVE DRIVING BOXES

BALTIMORE, Md.

TO THE EDITOR:

I have read with much interest the article by George J. Burns, on "Grease Lubrication of Locomotive Driving Boxes," in the May number of the *Railway Mechanical Engineer*, page 234. Careful reading of this will show that facts are presented, which, if given a trial, will prove that the author has based the statement on results that have already been obtained. The matter of lubrication of driving boxes is of vital importance, as the result of many failures can be directly attributed to a lack of it which often requires the locomotive to be taken out of service, new crown bearings applied, journals trued off and sometimes new axles applied. This, together with the drop pit work needed to remove the wheels and other work entailed, such as removing rods, etc., suggests how important a factor in reducing the cost of upkeep of a locomotive the suggestions given by Mr. Burns would prove, if put into practice. In too many cases it has been only too well proved that there is an obsession resulting from a long observance of usual practices. In railroad work, as well as in any other progressive work, the customs and practices of yesterday must be laid aside for improved practices of today and tomorrow. The narrow view that a practice, having been employed for 20 years, is the best practice simply because it has served the purpose, does not imply that other ideas cannot be employed, other methods put into effect and other systems inaugurated that will revolutionize the several old methods and produce far better results.

JOHN V. LE COMPTE.

Baltimore & Ohio Road Mallets

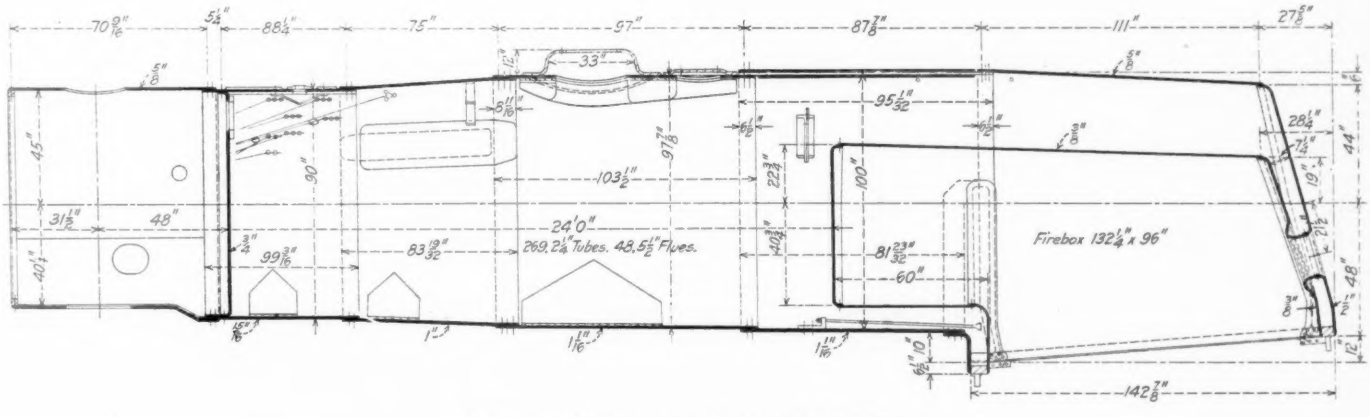
New 2-8-8-0 Type Locomotives Replace Simple 2-10-2 Type Engines on Grades Over Two Per Cent

Baltimore & Ohio Mallet Type Locomotive

The Baltimore & Ohio has recently received from the Baldwin Locomotive Works 15 Mallet articulated locomotives of the 2-8-8-0 type. These engines exert a tractive effort of 103,000 lb., and are used in road service on the Cumberland division, replacing single expansion locomotives of the 2-10-2 type, which have been transferred to a section of the road having lighter grades. The maximum grades on the Cumberland division are 2.4 per cent east bound and 2.28 per cent west bound. The traffic is very heavy, consisting chiefly of coal, and on few roads in this country are more difficult operating conditions to be found.

The boilers of the new Mallets are of the conical type, the second ring in the barrel being tapered, increasing the shell diameter from 90 in. at the first ring to 100 in. at the throat. As far as front end diameter, number of tubes and principal firebox dimensions are concerned, the boilers of the Mallets are similar to those of the 2-10-2 engines previously referred to.* The length of the tubes, however, is 24 ft., as compared with 23 ft. in the 2-10-2 type, and the combustion chamber is 32 in. longer. This accounts for an increase in total heating surface of 263 sq. ft. Both engines are equipped with Schmidt superheaters, the Mallets having 86 sq. ft. more superheating surface than the others. The grates and the arrangement of the cab fittings are practically alike in both engines, and both are fired by Street stokers.

The combustion chamber is 60 in. long, and the front end of the combustion chamber crown is supported on three rows of Baldwin expansion stays. There is a complete installation of flexible stays in the water-legs. The middle seam in the barrel, and the seams uniting the throat and outside firebox shell with the fourth ring are triple riveted. Some of the combustion chamber stays are necessarily tapped into the throat

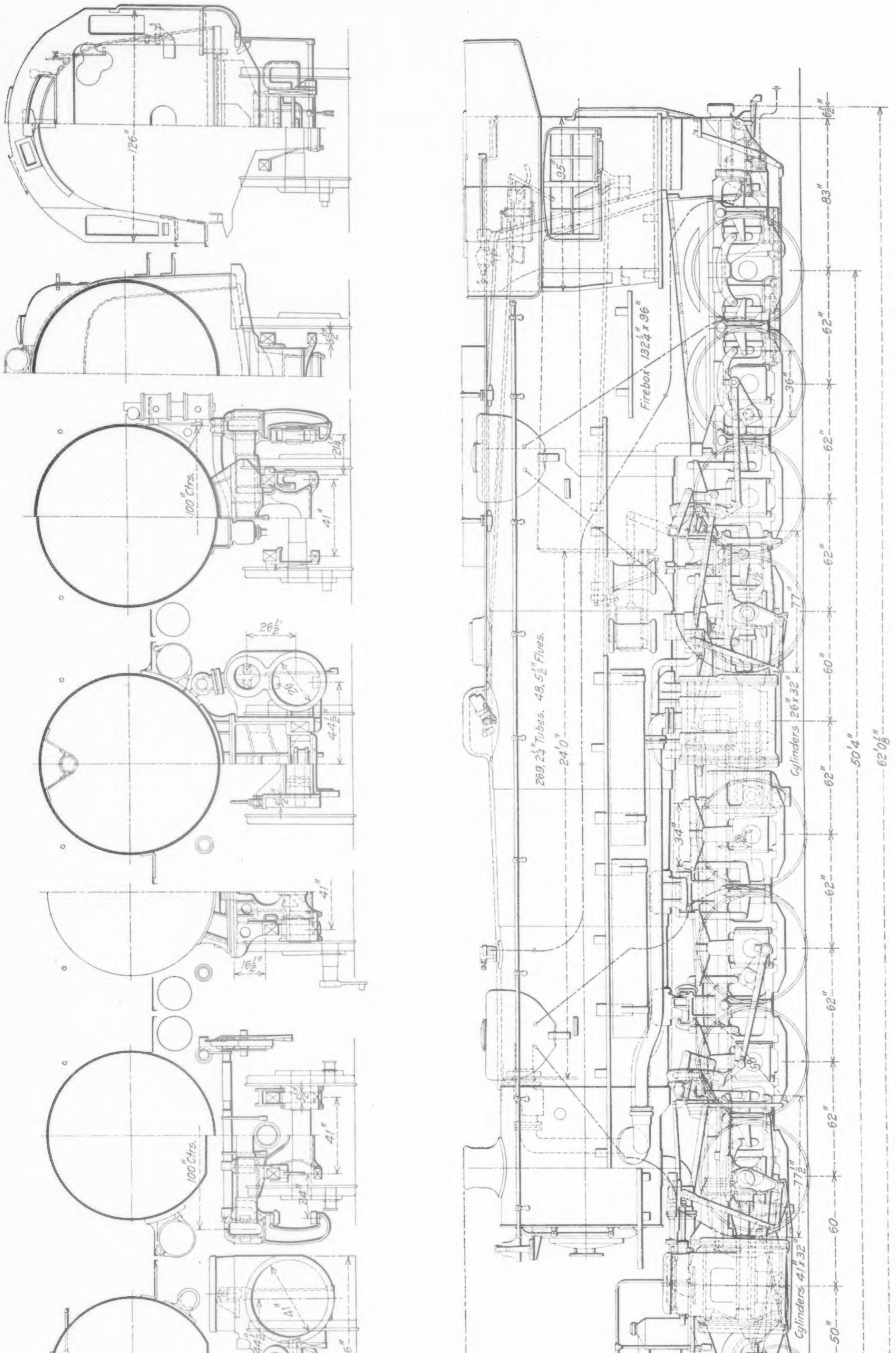


Boiler for the Baltimore & Ohio Mallet Type

and outside shell seams and where this occurs the stays are so located as to replace rivets in the center row. The Security brick arch, in the Mallet type, is supported on five 3-in. tubes. These extend from the bottom of the combustion chamber to the back sheet of the firebox. This arrangement of tubes improves the circulation in the horizontal water space under the combustion chamber, and as the arch tubes are comparatively long they add considerably to the firebox heating surface.

The shell plates of the boiler are heavy, those constituting

*For a description of these locomotives see the *Railway Age Gazette, Mechanical Edition*, for September, 1914, page 456.

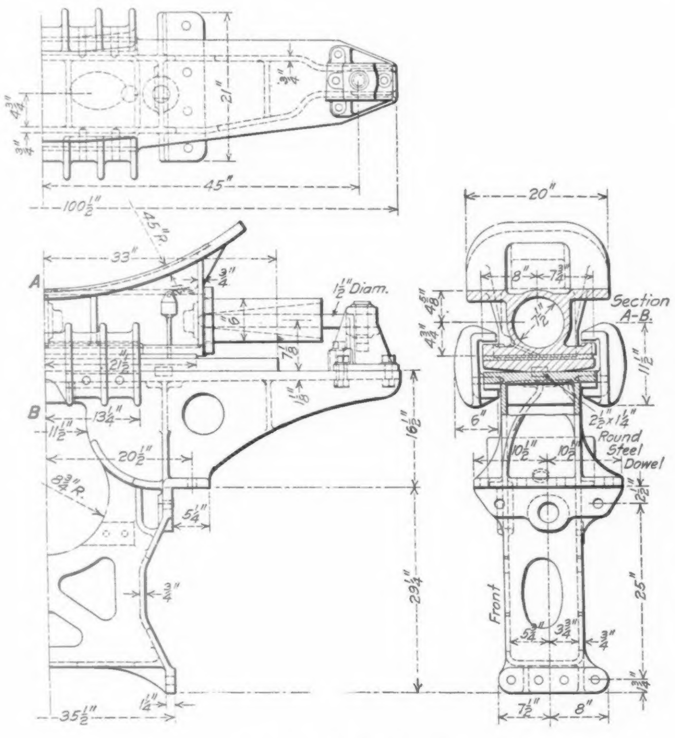


Elevation and Cross Sections of the Baltimore & Ohio Locomotives

the third and fourth rings being 1 1/16 in. thick. The high-pressure cylinder saddle and the two waist-bearers over the front frames are bolted to the boiler barrel, an inside liner being riveted to the shell in each case. Bolts, rivets and liners are electrically welded to insure tight joints.

The high-pressure steam distribution is controlled by 14-in. piston valves. These have cast iron bodies and malleable iron heads, while the bull-rings and packing rings are of Hunt-Spiller metal. The cylinders and steam chests are fitted with bushings of the same material. The high-pressure cylinder saddle consists of two steel castings, placed one above the other. The bottom casting is provided, on its top face, with lugs at the front and back and keys are driven in against the front lugs, thus making an exceedingly secure joint between the two sections of the saddle. The bottom section is cored out to receive the ball joint at the back end of the receiver pipe.

The low pressure cylinder castings are bolted together on the center line of the locomotive and the axes of these cylinders are set on an inclination of 1 in 39. The low pressure distribution is controlled by Allen ported balanced slide



Forward Waist Bearer

valves. The valve gears are of the Walschaert type, and are controlled by the Ragonnet power reverse mechanism. In accordance with the usual practice of the builders, the front and back reverse shafts are connected by a centrally located reach rod. This rod has a flexible joint which is guided between the inner walls of the high pressure cylinder saddle. The starting valve is of Baldwin design and is placed in a pipe connection leading from one of the high pressure steam pipes to the back end of the receiver pipe.

The high pressure pistons are of box form, each cast in one piece, Hunt-Spiller metal being used; the low pressure pistons have cast steel bodies of dished section on which iron bearing faces are cast. In neither case are extension rods used. The piston rods, main crank pins and main axles are of Nikrome steel.

The articulated connection between the front and rear frames is designed to provide ample flexibility. The radius rod is pinned to the front frames, and has a ball-jointed connection with the hinge-pin. The front and rear frames are neither interlocked nor connected by hanger bolts. For the rear group of wheels there is a continuous equalization system on each side of the locomotive, while in the case of the front group the equalization divides between the second and third pairs of drivers. The Cole design of long driving box is used on the main wheels. The front truck is fitted with three-point suspension links.

The boiler is supported on the front frames by two waist bearers both under load. The wear is taken in each case by a brass shoe 5/8 in. thick which is bolted to the upper section of the waist bearer. This shoe slides on a steel plate, finished transversely to a long radius on its under side, which is held in position by dowels entering the lower section of the waist bearer. The latter constitutes a most effective transverse brace, as it is bolted to both the upper and lower frame rails. The rear bearer supports the brake cylinders for the forward group of wheels, while the front bearer is fitted with the centering springs and suspension clamps.

These locomotives are designed to traverse curves as sharp as 22 deg. The play between rails and flanges is 1 in. on the front and rear wheels of each group of drivers, and 3/4 in. on the intermediate wheels. The weight distribution is very satisfactory, as there is a difference of only 1,100 lb. between the total amounts carried by the front and rear groups of drivers.

The Vanderbilt tender has been used on all the freight locomotives recently built for the Baltimore & Ohio. In the present case, the tank is of unusual capacity, as it carries 12,000 gal. of water and 20 tons of fuel. The wheels are of solid forged and rolled steel.

The principal dimensions and ratios are as follows:

General Data	
Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	103,000 lb.
Weight in working order	485,600 lb.
Weight on drivers	462,500 lb.
Weight on leading truck	23,100 lb.
Weight of engine and tender in working order	692,000 lb.
Wheel base, driving	41 ft. 2 in.
Wheel base, total	50 ft. 4 in.
Wheel base, engine and tender	87 ft. 5¼ in.
Ratios	
Weight on drivers ÷ tractive effort	4.5
Total weight ÷ tractive effort	4.7
Tractive effort × diam. drivers ÷ equivalent heating surface*	751.0
Equivalent heating surface* ÷ grate area	90.4
Firebox heating surface ÷ equivalent heating surface,* per cent	4.9
Weight on drivers ÷ equivalent heating surface*	58.0
Total weight ÷ equivalent heating surface*	61.1
Volume both cylinders	30.4 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	26.2
Grate area ÷ vol. cylinders	28.9
Cylinders	
Kind	Compound
Diameter and stroke	26 in. and 41 in. by 32 in.
Valves	
Kind	H. P., 14 in. piston; L. P., balanced slide
Wheels	
Driving, diameter over tires	58 in.
Driving, thickness of tires	4 in.
Driving journals, main, diameter and length	10½ in. by 16 in.
Driving journals, others, diameter and length	10 in. by 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 in. by 10 in.
Boiler	
Style	Conical
Working pressure	210 lb. per sq. in.
Outside diameter of first ring	90 in.
Firebox, length and width	132¼ in. by 96 in.
Firebox plates, thickness	sides, back and crown, ⅜ in.; tube, ½ in.
Firebox, water space	front, 6 in.; back, 4 in.; sides, 6 in. to 4 in.
Tubes, number and outside diameter	269—2¼ in.
Flues, number and outside diameter	48—5½ in.
Tubes and flues, length	24 ft.
Heating surface, tubes and flues	5,443 sq. ft.
Heating surface, firebox†	393 sq. ft
Heating surface, total	5,836 sq. ft.
Superheater heating surface	1,415 sq. ft.
Equivalent heating surface*	7,958.5 sq. ft.
Grate area	88.2 sq. ft.
Tender	
Weight	206,400 lb.

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

†Includes 113 sq. ft. combustion chamber heating surface and 52 sq. ft. arch tube heating surface.

Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	12,000 gal.
Coal capacity	20 tons

LOCOMOTIVE FIREBOX PROPORTIONS

BY LAWFORD H. FRY

In discussing the report of the Committee on Fuel Economy at the Master Mechanics' Association convention in 1915, the writer called attention to the necessity for sufficient firebox volume, and pointed out that the volume provided could be conveniently measured by the ratio of firebox heating surface to grate area. The present article is intended to discuss further the question of firebox volume and this proposed method of measuring it, and at the same time to deal with an objection which has been made.

Let us take first the question of firebox volume, and consider what happens during combustion, not so much the chemical but the mechanical action taking place. Air and coal are brought together for combustion. The air, by reason of the draft created by the blast pipe, is sucked in through the grate openings and firedoor, and swept through the firebox into the tubes and out through the smokebox. The coal, on being thrown into the firebox, is rapidly split up by the heat into fixed carbon and volatile matter. The fixed carbon lies on the grate and burns there with part of the air entering through the grate, while the volatile matter, which carries a very considerable proportion of the heating value of soft coal, is swept through the firebox with the remainder of the air and the smaller particles of coal carried off the grate by the draft. The volatile matter and the small particles of coal will be burned if they have an opportunity of coming into contact with the oxygen of the air while at the high temperature of the firebox. When the gases enter the tubes the temperature falls too low for combustion to continue. Consequently the completeness with which soft coal is burned will largely depend on the time and opportunity afforded to the gases for mixing in the firebox. A brick arch will greatly assist the mixing of the gases at high temperature, but firebox volume is of high importance. In practically any locomotive boiler an increase in firebox volume would mean an increase in opportunity for more complete combustion and consequently an increase in efficiency.

Now, in a locomotive firebox of a given grate area, an increase in firebox heating surface means an increase in firebox volume, and we may therefore say with quite sufficient accuracy that an increase in the ratio of firebox heating surface to grate area means an increase in the ratio of firebox volume to grate area; or going back to the previous proposition, we can say that an increase in the ratio of firebox heating surface to grate area means an increase in the efficiency of combustion.

This is undoubtedly true, but the superintendent of motive power of a large western road has pointed out to the writer that a high ratio of firebox heating surface to grate area does not necessarily indicate a desirable locomotive, and that it may, in fact, be accompanied by conditions which give undue difficulty in firebox maintenance. The point is illustrated by the four locomotives, the dimensions of which are given in Tables I and II. The locomotives of the three classes *A*, *C* and *D*, with respectively 4.45, 3.40 and 3.39 sq. ft. of firebox heating surface per square foot of grate area, are very satisfactory while the class *B* locomotives, with 5.28 sq. ft. of firebox surface per square foot of grate, give an undue amount of operating trouble from leaky staybolts.

An instructive lesson in locomotive proportions and in the use of ratios for comparing locomotives can be drawn from a consideration of this statement. In the first place we have our attention called to the fact that a single ratio is never sufficient for a criticism of a locomotive, the reason for this being that the value of the ratio may be increased by increasing one of the quantities compared or by reducing the other. For example, in a given design we can increase the figure for the firebox heating surface per square foot of grate area, either by increasing the firebox surface or by reducing the grate area. Therefore a high ratio may mean either ample firebox surface (which would give ample firebox volume), or it may mean a restricted grate area. Our conclusion that an increase in the ratio of firebox surface to grate area gives an increase in efficiency is based on a comparison in which the rate of combustion per square foot of grate area is the same. If the boiler with the larger volume ratio has to be forced to a higher rate of combustion per square foot of grate, all the efficiency gained by the greater volume may be lost, and further drawbacks may be introduced. As we shall see, this happens in the case of the class *B* locomotives. To study this side of the question we need some measure for the relation between the size of the grate and the service for which the locomotive is intended, and for this purpose the rated tractive effort per square foot of grate area is suggested. The values of this for the four locomotives referred to above are shown in Table II. The rated tractive effort is calculated by the usual formula from the cylinder and driving wheel dimensions, using 85 per cent of the boiler pressure as mean effective, and the table shows in column 7 the rated tractive effort per square foot of total heating surface and in column 8 the rated tractive effort per square foot of grate area. It will be seen that while classes *A*, *C* and *D* have from 808 to 860 lb. of tractive effort per square foot of grate, class *B* requires each square foot of grate to furnish no less than 1,005 lb. of tractive effort. This means that to develop the same proportion of total power the class *B* locomotives must have the combustion per square foot of grate forced from 20 to 25 per cent harder than the other classes. Herein lies the cause of the firebox and staybolt trouble with this class. The forcing of the fire means an excessively high firebox temperature which is detrimental to the life of the box, both by its direct action and by reason of the great drop in temperature produced when the engine is shut off.

It is interesting to compare also the figures for tractive effort per square foot of total heating surface. On this basis of comparison the class *B* engine makes the best showing, having only 11.2 lb. per square foot, while class *D* has 11.8, class *C*, 14.8 and class *A*, 17.0 lb. of tractive effort per square foot of grate. These figures show that if the four locomotives are loaded in proportion to the cylinder dimensions, class *B* will of all four engines make the greatest demand on the grate and the least on the evaporative power of the heating surface. And if the matter be put the other way about and the loads of the four engines be proportioned to the dimensions of the grates, class *B* will make a very favorable showing so far as efficiency of steam production is concerned, as both the large proportion of firebox surface per square foot of grate and the large proportion of total heating surface per square foot of grate make for boiler efficiency. As a whole, however, our conclusion will be that the class *B* engine could be improved by an increase in the area of the grate, the other dimensions remaining as they now are.

Returning now to general principles we can say that a high ratio of firebox heating surface to grate area is desirable when it is obtained by giving ample firebox surface and undesirable when obtained by a restricted grate area. A usual figure in large modern locomotives is 3.5 sq. ft. of firebox to each square foot of grate area. It would be better to have 4.0 sq. ft., and 4.5 sq. ft. can be obtained in some cases and should be aimed at where practical. It will usually be found impossible to do better than this if the grate area is full size. As a general indication of modern practice in the

proportions of grate area to tractive effort the following figures are given:

Type of locomotive		Rated tractive effort in lb. per sq. ft. of grate area
4-4-2	Saturated	500
	Superheated	600
4-6-2	Saturated	550
	Superheated	650
2-8-0	Saturated	825
	Superheated	925
2-8-2	Saturated	775
	Superheated	875

These figures are for soft coal burning locomotives, and the aim should be not to exceed them, or, in other words, to provide as much grate area as is practicable.

TABLE I—PROPORTIONS OF HEATING SURFACES AND GRATE AREA

1	2	3	4	5	6
Class	Firebox heating surface, sq. ft.	Total heating surface, sq. ft.	Grate area, sq. ft.	Sq. ft. of total heating surface per sq. ft. of grate area	Sq. ft. of firebox heating surface per sq. ft. of grate area
A	140	1,498	31.5	47.6	4.45
B	162	2,814	30.8	91.4	5.28
C	167	2,844	49.0	58.0	3.40
D	187	3,839	55.1	69.6	3.39

TABLE II—TRACTIVE EFFORT FACTORS

1	2	3	4	5	6	7	8
	Cylinder						
Class	Diam., in.	Stroke, in.	Driving wheel Diam., in.	Boiler pressure, lb. per sq. in.	Rated tractive effort, lb.	Lb. tractive effort per sq. ft. total heating surface	Lb. tractive effort per sq. ft. of grate area
A....	20	24	50	150	25,400	17.0	808
B....	20	28	62	205	31,400	11.2	1,005
C....	22	28	56	205	42,000	14.8	860
D....	24	28	62	205	45,300	11.8	825

WATER TREATMENT ON THE MISSOURI PACIFIC

During 1915, 604,470,000 gal. of water were treated by softening plants on the Missouri Pacific, removing from this water 1,816,837 lb. of scale-forming solids. There are 33 water-treating plants in operation on the main and branch lines between St. Louis, Mo., and Pueblo, Colo., which have been in service from 5 to 10 years, and represent a total investment of $70,450. On the basis of a saving of 7 cents per pound for incrusting matter kept from entering the engine boilers, as outlined by the water service committee of the American Railway Engineering Association in 1914, the total saving to the railway from the removal of this scaling material amounted to $127,171. From this must be deducted $26,717 for the cost of treatment, including additional labor, chemicals, maintenance and 10 per cent to cover interest and depreciation in the treating facilities, leaving a net saving of $100,454.

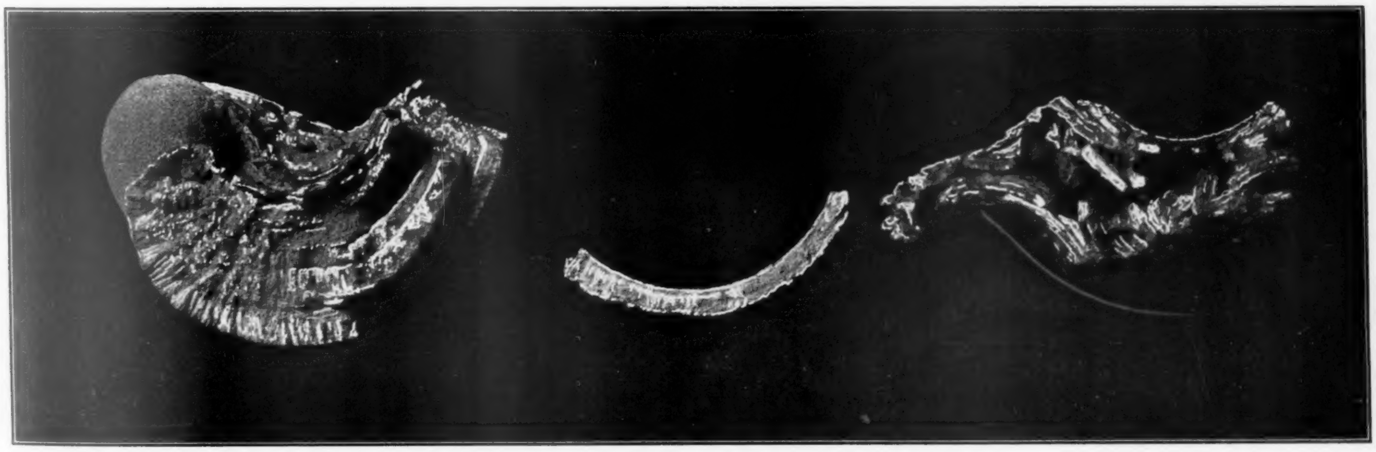
In arriving at the figure of 7 cents per pound for incrusting matter removed, the committee realized that the benefits derived from water treatment are numerous, but usually of an intangible nature. However, values were placed on four of them—loss of fuel resulting from the insulating effect of the scale, renewal of tubes, repair work on tubes and boilers in the roundhouse, and the loss of engine time during repairs. On account of its intangible nature and the difference in the relation on the various districts, the reduction of engine failures was not considered in determining the above figure. It has been found that the average cost per engine failure, exclusive of labor and material for repairs, amounts to $17, and on one division the engine failures resulting from boiler troubles were cut down over 1,000 per year by the treatment of the water, thereby giving a saving in this one item alone of $17,000. From this it is seen that 7 cents is very conservative.

The accompanying table shows the character and source of supply, the amount of water treated, the amount of incrustants removed, the cost of plant, and the cost of operation of the 33 plants during the year 1915. The amount of scale removed was derived by checking the raw water hardness against the incrusting solids still remaining in the water after treatment.

Of the 33 plants on the Missouri Pacific, 16 are of the intermittent, and 17 of the continuous type, of various designs. The majority were installed by company forces under the supervision of the superintendent of water service, and each one was designed to fit the individual station with a view to providing for the maximum use of the existing facilities. Material changes have been necessary in some of the first plants installed, but all have paid for themselves many times over, and after several years of service are still yielding 142.5 per cent on the investment.

Many of the stations were equipped for softening the water at a remarkably small expense. Intermittent plants were provided by placing a second tank beside the old one and equipping each with air-agitating pipes, each serving alternately as a storage and a treating tank. Where penstocks are used, the pumper manipulates the valves into the discharge line so that the proper tank is connected at all times. Where engines take water direct from the tank, each one is equipped with a spout, the operator placing a white flag on the tank from which water is to be taken.

The most inexpensive plant is built inside a roadside tank and consists of a shallow box placed under the roof of the tank to act as a mixing basin for the chemicals and water. The mixture then flows down through a large discharge pipe to the bottom of a small inside tank about 10 or 12 ft. in diameter, from which it is discharged at the top through an 18-in. excelsior filter into the tank proper, which serves as a storage compartment. At small stations where the rate of pumping does not exceed 4,000 or 5,000 gal. per hour, this plant has proved very successful and economical,



Scale from Untreated Water

but where the rate of upward flow of the water requires it to pass the filter in less than three hours, there is a strong tendency for the sludge to be carried over, resulting in milky water, which induces foaming. The chemicals are put in with a small simple displacement plunger pump and the mixture is regulated by the chemist's instructions of so many inches from the chemical vat per foot of water in the tank.

A continuous plant for larger capacities has given very good service. In this case the chemicals and water mix in a small box at the top of the tank, and because of the large volume of water going through a small space very thorough agitation is secured. The mixture then goes down through an inside steel tube 6 ft. in diameter, which quiets all eddies, and comes up in an outside storage tank with no filter. By proper treatment of the water a good, clear effluent is obtained at the height of 18 ft. in a tank 30 ft. in diameter, pumping at the rate of 25,000 gal. per hour. The amount

Station	Source of Supply	Raw Water Hardness in Grams Per Gal.	Annual Consumption in Gallons	Pounds of Scale Removed	Original Cost of Treating Facilities	Total Additional Cost for Treatment	Total Saving
Auburn, Neb.	Well	30	25,857,950	85,330	$ 7,500	$ 2,156	$ 5,973
Berlin, Neb.	Well	28	3,170,400	10,463	1,500	243	732
Brownell, Kan.	Well	12.5	15,990,000	23,965	750	296	1,679
Bushton, Kan.	Well	16.0	11,640,755	20,370	750	234	1,426
Caney, Kan.	Creek	12 - 28	3,648,000	7,276	1,500	424	509
Cedarvale, Kan.	Creek	12 - 18	3,316,600	4,975	750	295	348
Concordia, Kan.	Well	35.0	10,164,300	40,738	2,300	545	2,852
Downs, Kan.	Well	16.0	11,137,000	16,707	6,500	824	1,170
Eads, Colo.	Well	23.0	8,470,000	15,246	2,000	385	1,067
Greenleaf, Kan.	Well	24 - 40	10,593,387	37,076	3,000	801	2,595
Gypsum City,Kan.	Creek	12 - 40	12,194,000	36,582	3,000	685	2,562
Haswell, Colo.	Well	27.0	13,270,000	46,445	2,000	550	3,251
Herington, Kan.	Creek	20 - 65	8,149,000	40,745	3,000	882	2,852
Hoisington,Kan.	Well	16 - 18	61,940,000	123,880	5,000	1,235	8,672
Holton, Kan.	Well	35.0	3,318,030	14,931	2,000	448	1,045
Jamestown, Kan.	Well	18 - 22	7,245,220	14,490	750	145	1,014
La Plotte, Neb.	Creek	10 - 19	13,655,000	31,406	750	207	2,198
Le Roy, Kan.	Creek	10 - 20	18,027,000	27,040	3,000	620	1,893
Lenora, Kan.	Well	20.0	2,746,000	5,492	350	102	384
Marquette, Kan.	Well	18 - 30	21,581,450	64,744	750	557	4,532
Oak Mills, Kan.	Well	27.5	5,977,500	13,150	1,500	393	921
Olcott, Kan.	Well	18.0	1,963,000	3,926	800	153	275
Ordway, Colo.	Reservoir	25 - 45	18,167,000	90,835	3,000	1,215	6,358
Pueblo, Colo.	Well	18 - 30	31,800,000	95,400	2,500	942	6,678
Roper, Kan.	Creek	10 - 18	9,490,800	14,236	500	227	996
Scott City, Kan.	Well	11.5	19,855,000	19,855	2,000	580	1,390
Sedalia, Mo.	Well	18.0	18,250,000	36,500	1,500	234	2,555
Seneca, Kan.	Well	22.0	5,098,800	13,257	2,000	409	928
Union, Neb.	Creek	6 - 18	21,405,000	21,405	2,000	500	1,498
Weeping Water,Neb.	Creek	6 - 18	8,376,400	8,376	2,000	374	586
Wichita, Kan.	Well	50.0	66,158,000	330,790	750	3,237	23,155
Winfield, Kan.	Creek	12 - 25	4,501,500	9,002	1,500	397	630
Kansas City, Mo.	Well City Water	35.0 8 - 22	127,310,000	492,105	10,000	6,421	34,447
	TOTALS		604,468,087	1,816,837	$70,450	$26,717	$127,171

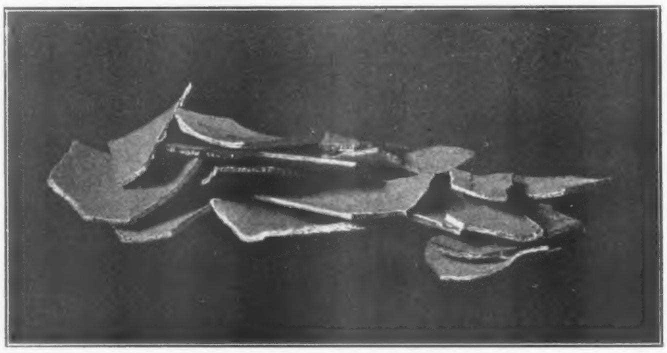
Conditions at the Treating Plants

of chemicals is regulated and supplied by a small plunger pump, as in the other style of plant.

The water-treating plants are operated by pumpmen under the supervision of the division water service foreman. The treatment is regulated by a chemist stationed at Kansas City, the most central location. Samples of both the raw and treated water are sent to him from each plant twice a week. Formulas are changed and any failures are investigated by him, and he is directly responsible for the results secured. Any corrections or changes found necessary are made by the division forces. Reports of the semi-weekly tests are furnished the general and division offices. A content of not more than six grains of incrusting solids per gallon in the treated water has been made a standard and any failure to meet this requires an explanation.

The treatment in general is gaged by the direct effect on the locomotive boilers. During his inspection trips the chemist consults the master mechanic, foremen and head boilermakers at the engine terminals as to the results obtained and checks failures due to leaking through daily reports. For many points where a softening plant will be located eventually on account of the hardness of the water, the scaling effect is overcome to a large extent by overtreatment at the nearest adjacent treating plant. Tests of the water taken from engine boilers on the various districts are frequently made and the treatment is adjusted as far as possible to give an excess of caustic alkalinity from sodium hydrate in the boilers at all times. Where it has been impossible to do this with the present treating facilities, excellent success has been obtained by the introduction of soda ash direct into the engine boilers through the washout holes after each washout, in amounts determined by the chemist. On account of the large amount of sludge and mud formed in the boilers, foaming conditions result, but this has been kept at a minimum and no serious trouble has been experienced. An anti-foaming compound prepared by the company's chemist is used to take care of this feature. Before soda ash was used in this manner the engine failures on one division from boiler troubles were 19.1 per 100,000 engine miles, but they were reduced to 9.1 in 1915, when the soda ash treatment was in effect. Only five failures due to foaming occurred during the same year, a lack of compound being responsible for three of the five. Records show that continuous improvement is being made with the increased familiarity in handling.

From the figures shown it is not difficult to determine the



Scale, Less Than 1/16 In. Thick, from Treated Water

advantages secured. The life of tubes has been increased from 50 to 300 per cent. Engine failures on one division have been decreased from 1,435 in 1910 to 202 in 1915, resulting almost entirely from the decrease in boiler failures in consequence of the use of soda ash and treated water. On the same division the boilermaker force has been reduced from 17 to 7 at the terminal roundhouse, a saving of $15,000 per year in this item alone.

At the Sedalia, Mo., power plant, where the water is treated for five Babcock & Wilcox double-deck water tube boilers of 275 hp. each, 715 of the 840 four-inch tubes have been in continuous service for the past eleven years on treated water. On account of the shortage of boiler capacity and the unavoidable heavy duty, there has been insufficient time to shut down these boilers for washing out and two of them ran for five years between washouts, at the end of which time the scale on the tubes was less than 1-16 in. thick. With raw water, tube failures were frequent and scale heavy.

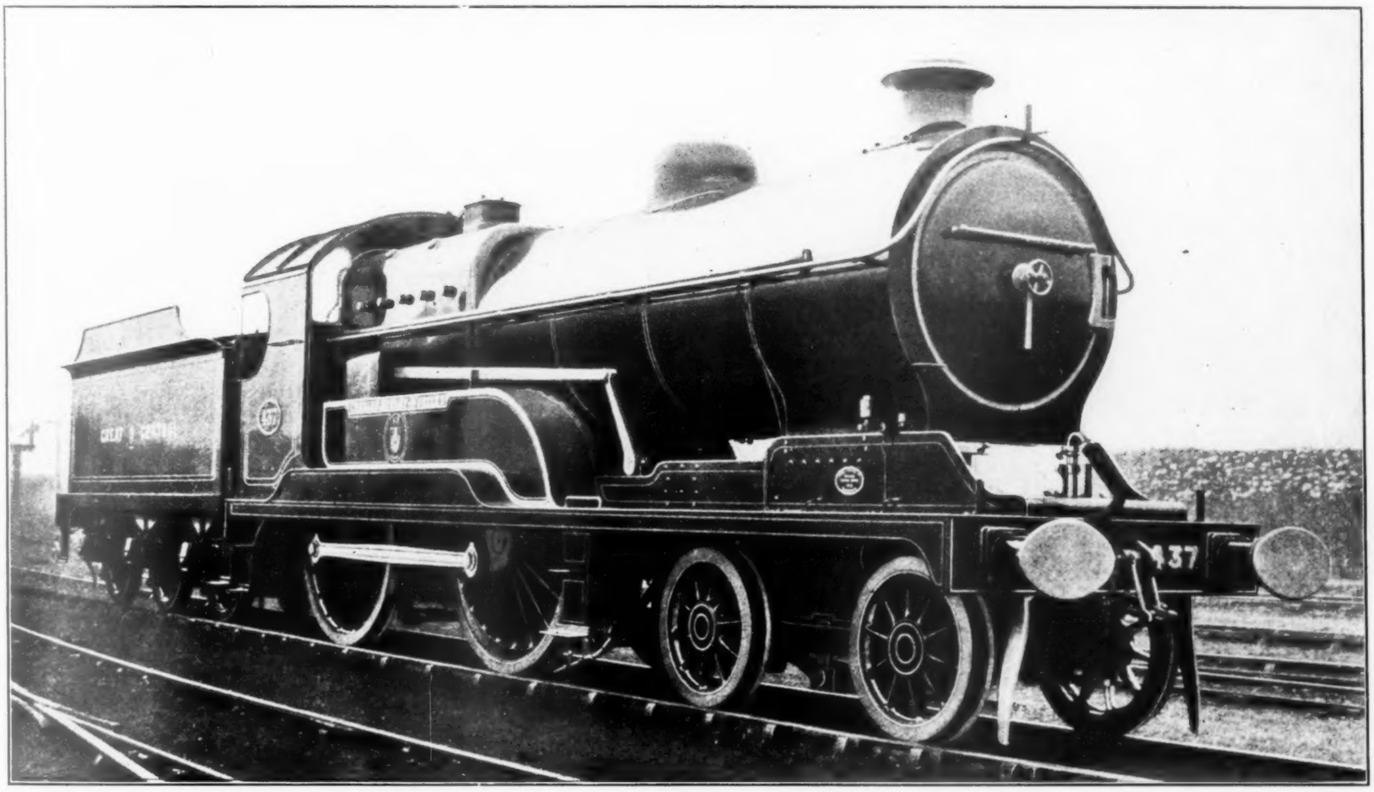
The photographs show some samples of boiler scale, illustrating the difference between treated and untreated water. The one at the left in the larger photograph shows a piece of scale 1½ in. thick, taken from a front tube sheet after 10 months' service. The one in the center shows a sample of sulphate scale ¼ in. thick, which put a boiler out of commission after three months' service. The one at the right shows a specimen of scale entirely clogging up the space between boiler tubes after eight months' service. The other photograph shows small fragments taken from locomotive boiler tubes after two years' service on the same district after the installation of treating plants and use of treated water.

An Eight-Wheel English Locomotive

Engines of This Type, With Superheaters, Hauling Fast Passenger Trains on the Great Central

THE 4-4-0 type locomotive is at the present time performing some of the heaviest and fastest express passenger work on British railways. The loading of the trains is in many cases exceedingly heavy, and even with the tendency towards lower rates of speed as now practiced on some lines the average speeds rule high, and are consecutively maintained for runs of long duration without intermediate stops.

The 4-4-0 type locomotive is economical to build, while its maintenance costs are somewhat lower than those of locomotives having more extended wheel arrangements. As compared with the 4-4-2 type the 4-4-0, built in accordance with the most modern standards, is capable of doing equal work, and on the majority of railways the latter class may be said to have outlived the popularity and usefulness of the Atlantic type, which at one time appeared likely to supersede the 4-4-0 type for the most important and fastest passenger traffic.

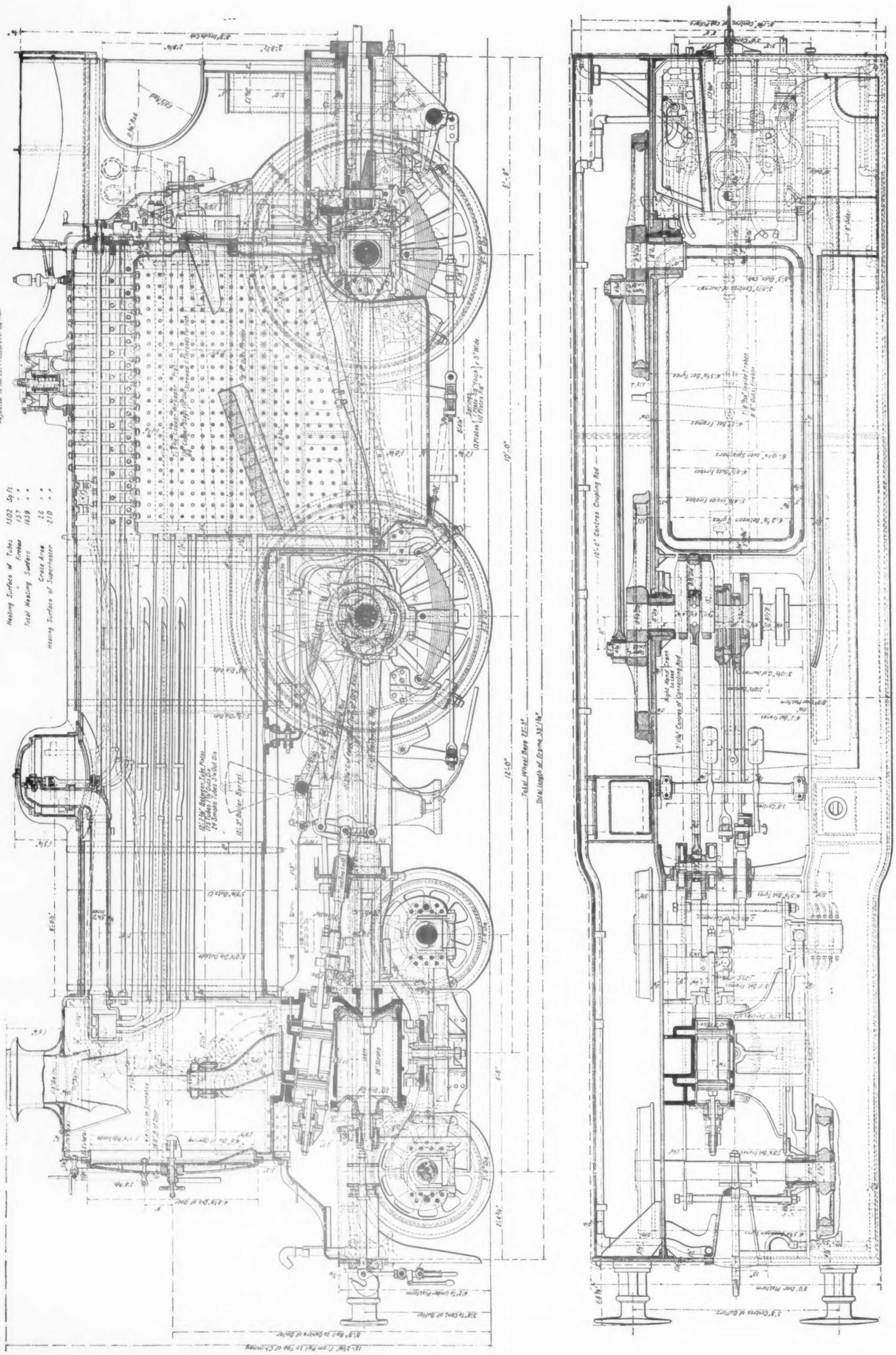


Locomotive of the 4-4-0 Type for Fast Passenger Service on the Great Central Railway of England

The advent of the superheater has perhaps been responsible, as much as, if not more than anything else, for the retention of the 4-4-0 type locomotive in the front rank. The use of superheated steam in large cylinders and in conjunction with a boiler designed with ample heating surface and a sufficient capacity has resulted in largely increasing the scope of a locomotive planned on the 4-4-0 wheel arrangement, and although the type has receded in other countries its position seems to be assured on British railways for some time to come where the principal main line passenger service is concerned. Without the superheater it is hardly possible that this type of locomotive would have continued to figure so prominently in present-day British locomotive practice, and although the benefits conferred by superheating are by no means restricted to any one class of locomotive its influence is perhaps more appreciably felt with the 4-4-0 type than with other and heavier locomotives.

The design of a 4-4-0 type locomotive in accordance with the ideas prevailing in England is based on simple and straightforward principles. The majority of such engines are equipped with inside cylinders to which superheated steam is distributed by means of piston valves actuated by one or other of the more simple forms of valve motion. There is an entire absence of complication of detail and frictional losses are thereby reduced to a considerable extent, so that the engine develops its power under the most favorable circumstances and the tractive effort it exerts is available for the purpose of dealing with heavy paying loads instead of a disproportionate amount of power being absorbed by moving the locomotive itself.

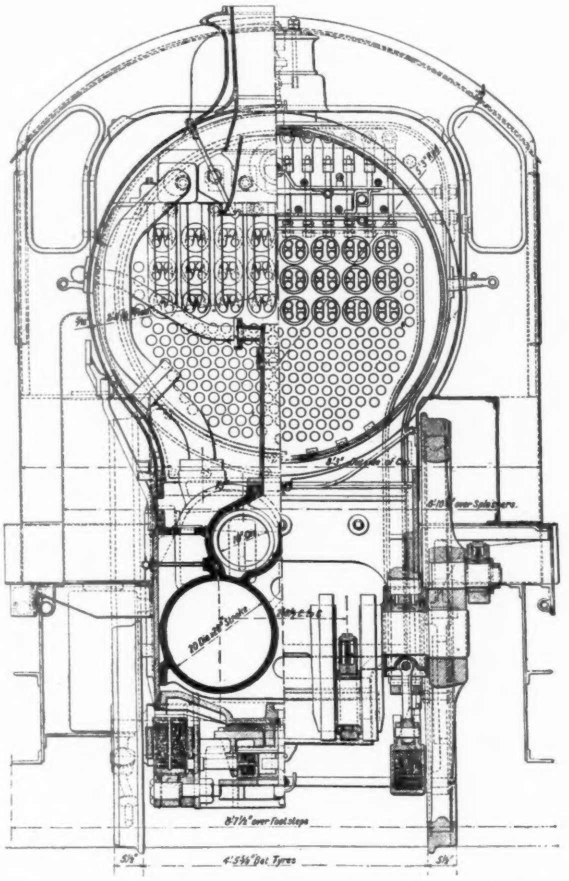
As an example of a modern design of the 4-4-0 type locomotive in England, there is illustrated herewith an engine of the "Director" class introduced on the Great Central Railway by the chief mechanical engineer, John G. Robinson. These engines have proved successful in every way in hauling the fastest and heaviest trains on that road. They are economical in fuel consumption, and as test runs have shown are capable of reaching very high speeds with heavy train loads. In these engines it was sought to combine the necessary features for the development of a high power capacity while retaining a general construction which is simple. The cylinders are placed between the frames at a distance of 2 ft. $0\frac{1}{2}$ in. between centers. Superheated steam is distributed to the cylinders by outside admission piston valves 10 in. in



Sectional Elevation and Plan of the Great Central Railway Eight-Wheel Passenger Locomotive

diameter which work above the cylinders. The cylinders are fitted with the Robinson pressure release valve, the two valves at each end of the cylinder being combined in a single casting; that is to say, there are two such castings, each containing two valves which communicate by means of a perforated connecting pipe. These pressure release valves combine the functions of air valves, water relief valves and compression release valves when running without steam.

The valve spindle packing, which is exposed to the superheated steam, is composed of a special bronze instead of the usual lead and antimony white metal. The piston rod packing which, owing to the expansion of the steam in the cylinder, is always at a much lower temperature, is of the usual lead-antimony mixture. The packings are of the standard type as used on non-superheater locomotives, as it is found that no need exists for special packing even when using superheated steam of over 700 deg. F. in the steam chest. It is found, however, that when the steam chests are above the



Cross Sections of the Great Central Locomotive

cylinders white metal gives trouble for the valve spindles, but not when they are below, because the steam is cooled in passing over the cylinder barrels on its way to the steam chest. The front ends of the valve spindles are carried by brackets cast on the front steam chest covers, a renewable cast-iron sleeve being fitted on the end of the spindle to take the wear. The back end of the spindle is supported by a special three-bearing bayonet joint which transfers the valve drive from the center line of the valve rod to that of the spindle. The engines are fitted with the Stephenson type of valve motion.

The engine truck has a cross travel of 6½ in. which is controlled by a strong elliptic spring. It is otherwise of the ordinary construction with cross slides and the usual spring arrangement.

The boiler, which has a diameter at the front end of 5 ft. 0½ in. outside and 5 ft. 3 in. diam. outside at the firebox end, contains a Robinson superheater of 24 elements. These elements are of the short return type in order to permit as large a flow of hot gases through the large tubes as possible. It has been found that any greater return length than about half that of the tubes results in a loss of superheat and to such an extent that it more than counterbalances the small gain in evaporative efficiency that results when the elements are returned the full length of the tube. There are no superheater dampers in this design. A small quantity of steam from the boiler, controlled by the same valve that operates the blower, is circulated through the superheater when steam is shut off. This prevents the oil delivered by the mechanical lubricator from accumulating and so causing carbonaceous deposits to form on the walls of the steam chest and on the ports, valves and pistons. A double beat valve, connected by a tappet and rods to the regulator handle, is so arranged as to open as soon as the throttle is closed, and to close just as the throttle opens. This serves to prevent any possibility of the circulating steam accumulating in the steam chest and so starting the engine should the valve controlling it be left open after the engine stops. As this circulation is not needed when the engine, and therefore the mechanical lubrication, has stopped, the circulating and blower valve is so made that it can be turned to a position to supply the blower only when standing and, of course, to shut off both when required.

The 2-in. pipe by which the double seated valve empties the header and steam pipe connects with the base of the exhaust pipe, thus discharging through the stack to the atmosphere, by which means the noise of the exhaust is much softened.

The "Director" class locomotives at present consume just under 39 lb. of coal per mile, which is but little more than the compound superheater engines of the Great Central Railway, which have the 4-4-2 wheel arrangement, and much less than the saturated steam heavy express engines on the same line. The normal train loadings on the Great Central are not, where passenger traffic is concerned, as heavy as those on certain other railways, but the grades are such as to make difficult work for the engines, especially in view of the high speed of the more important trains. The average grading of the line south of Leicester is 1 in 176. The "Director" class locomotives have not as yet been indicated or tested with a dynamometer car, but there is no doubt that they can maintain over 1,000 indicated horse-power and can be made to develop over 1,200 indicated horse-power, considering them in comparison with the work done by certain other engines on this road.

The cylinder tractive effort at starting is 19,500 lb. and at 60 m.p.h. about 6,500 lb. As compared with certain saturated steam engines on this road, which are employed as a rule on lighter trains, the coal consumption is nearly 18 per cent lower, so that for equal loading the economy would be considerably more. The working temperature of the steam as delivered from the superheater is from 650 to 670 deg. F.

Of the total weight of 136,600 lb., 88,500 lb. is available for adhesion purposes. The tender is of the six-wheel type with capacity for 4,000 gallons of water and six (long) tons of coal. It is equipped with steam operated water pick-up apparatus. Its wheelbase is 13 ft.

The cylinders and valves are lubricated by means of a ten-feed Wakefield's lubricator and the boiler is fed by two 10 mm. injectors. The engine is fitted with automatic vacuum brake apparatus for the train, with hand or vacuum controlled steam brakes on the engine and tender, and with hand brakes on the tender.

On one occasion the locomotive illustrated hauled a train weighing 203 (long) tons from Leicester to London in 104 min. from start to stop, an average speed of about 60 m.p.h., which was for the most part exceeded to allow for the com-

pulsory reductions of speed at the various slow down points.

The following are the leading particulars:

Cylinders, diameter and stroke	20 in. by 26 in.
Driving wheels, diameter	6 ft. 9 in.
Truck wheels, diameter	3 ft. 6 in.
Wheelbase, driving	10 ft.
Wheelbase, engine and tender, total	48 ft. 8½ in.
Heating surface—	
Tubes	1,502 sq. ft.
Firebox	157 sq. ft.
Total evaporating surface	1,659 sq. ft.
Superheater	210 sq. ft.
Grate area	26 sq. ft.
Working pressure, per sq. in.	180 lb.
Weight on drivers	88,500 lb.
Weight of engine in working order	136,600 lb.
Weight of engine and tender in working order	244,700 lb.

HEAT TREATMENT OF CARBON-STEEL LOCOMOTIVE AXLES: WATER VS. OIL QUENCHING*

BY C. D. YOUNG
Engineer of Tests, Pennsylvania Railroad, Altoona, Pa.

The investigation reported in this paper was made in order to show the difference between the physical properties of a large forging quenched in water and those of a similar forging quenched in oil.

The results obtained indicate that there is an advantage in the use of water as a quenching medium, as might be expected from its physical properties. Results obtained at a large heat-treating plant, which has turned out thousands of tons of quenched and tempered carbon steel, indicated that no disastrous effects on the forgings are to be anticipated from the use of water as a quenching medium, providing proper care is taken in the handling of the steel throughout the process.

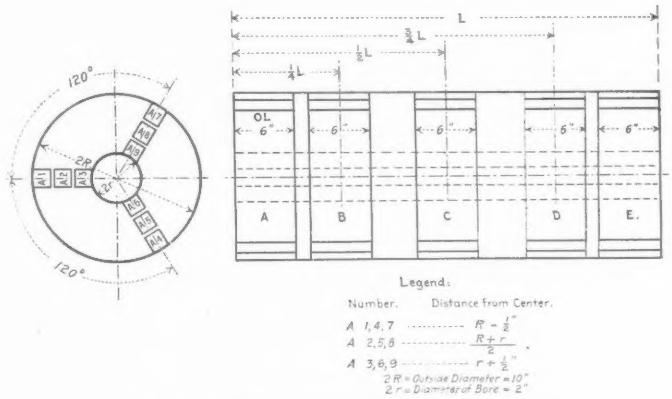
The forgings used for this experiment consisted of two 10-in. locomotive driving axles having a center bore 2 in. in diameter extending the entire length. Both axles were from the same melt of steel, and preliminary chemical analysis indicated the same chemical composition. One axle was treated at the Juniata Shops of the Pennsylvania Railroad by water quenching, and the other axle by a steel company which makes a practice of oil quenching.

Water Quenched.—The axle was heated to 1,550 deg. F., and at that temperature quenched in water at about 60 deg. F. Then, in a furnace maintained at 1,175 deg. F., it was heated to that temperature and cooled therefrom in the air on a dry ground floor. That is, this axle, after being quenched from 1,550 deg. F. in water at about 60 deg. F., was "drawn" to a temperature of 1,175 deg. F.

Oil Quenched.—Similarly, the other axle was quenched in a heavy oil from the same temperature (1,550 deg. F.) and drawn in a furnace to 1,200 deg. F., the cooling being done in the air the same as for the water-quenched axle.

The object aimed at in the above treatment was to have the tension tests on both axles show an elongation in 2 in. of about 22 per cent.

After treatment, the axles were laid off for cutting up into tension test speciments as shown in the diagram. It will be noted in effect that out of each axle there were cut—axially and for the full length, 120 deg. apart—three radial and straight slabs of the overall-thickness of a test specimen, and out of each slab five 6-in. lengths, each identified as to its original location in the axle, whether cut from the end and from which end, or whether from the center, or from midway between center and end, and from which slab; and then each 6-in. length was cut lengthwise into three specimens and their locations further identified as to whether cut from the inner or outer circumference or from the middle of the wall. The identification marks for the five 6-in. lengths, in order from one end, are respectively *A*, *B*, *C*, *D*, and *E*. It is also shown that the specimens from length *A*, for example, are numbered radially from the outside of the axle toward the axis, the three specimens from the first slab being numbered, as described, 1, 2, 3 throughout; second slab 4, 5, 6; third slab 7, 8, 9, respectively. The specimens from lengths *B*, *C*, *D* and *E* also have the same numbering as those of length *A*. The letter *W* applies only to the water-quenched axle and *O* only to the oil quenched. Altogether there were 45 specimens per axle, 15 specimens from the three longitudinal planes through the axle, and 9 specimens from all three slabs from each of the five 6-in. lengths.



Location of Test Specimens Cut from Axles

TABLE I—SUMMARY OF RESULTS OF TESTS

Location from End	Location from Axis	Specimen Marks Water Quenched	Specimen Marks Oil Quenched	Elastic Limit. Lb. per sq. in. Water Quenched	Elastic Limit. Lb. per sq. in. Oil Quenched	Tensile Strength. Lb. per sq. in. Water Quenched	Tensile Strength. Lb. per sq. in. Oil Quenched	Elongation in 2 in. Per cent Water Quenched	Elongation in 2 in. Per cent Oil Quenched	Reduction of Area. Per cent Water Quenched	Reduction of Area. Per cent Oil Quenched
Location from End											
OL	....	*WA*	*OA*	54,857	51,250	97,111	97,650	22.1	23.2	39.9	41.9
L/4	....	*WB*	*OB*	52,634	52,160	96,637	97,304	22.8	25.2	40.3	45.7
L/2	....	*WC*	*OC*	55,626	51,230	96,472	96,880	23.7	25.1	44.0	46.8
3L/4	....	*WD*	*OD*	56,064	51,170	96,470	96,030	23.1	23.5	42.5	40.7
L	....	*WE*	*OE*	53,376	49,780	95,720	94,210	23.6	24.0	44.3	41.7
Average				54,509	51,118	96,482	96,415	23.1	24.2	42.2	43.4
Location from Center											
....	$R - \frac{1}{2}$ in.	*W* 1, 4, 7	*O* 1, 4, 7	55.216	51,423	94,187	93,719	25.6	26.0	52.7	49.7
	$\frac{R+r}{2}$	*W* 2, 5, 8	*O* 2. 5, 8	51,064	48,390	95,508	92.572	24.4	25.5	44.5	45.8
....	$r + \frac{1}{2}$ in.	*W* 3, 6, 9	*O* 3, 6, 9	57.255	53,543	99.751	102,962	19.2	21.2	29.7	34.5
....	$\frac{R+r}{2}$	Minimum permitted by A. S. T. M. specifications		50,000		80,000		20.0		40.0	

*From a paper read at the convention of the American Society for Testing Materials, Atlantic City, N. J., June 27-30, 1916.

The test specimens were turned up to the standard 2-in. gage length, 1½ in. in diameter. The elastic limit was determined by means of a strain gage. All tests were conducted on the same 100,000 lb. tension testing machine using a machine speed of ⅛ in. per minute for both the elastic limit and the tensile strength.

The results are summarized in Table I, in which it is shown that the average results are more nearly uniform with respect to the length of the axle than with respect to distance from the axis. This is probably due to segregation, as it was found by chemical analysis that the carbon content was not uniform throughout the section. Segregation is perhaps to be expected in the ordinary output of commercial forgings, but not to the extent found here. (See Table II for chemical segregation.)

A comparison of the average physical properties of all test specimens from both axles shows that with an elongation 4.5 per cent less than that of the oil-quenched axle, resulting from the difference in treatment, the water-quenched axle gave an elastic limit 6.6 per cent greater, about the same tensile strength and nearly the same reduction of area.

Table I gives the average results from all test specimens located equidistant from the axis in each axle. The average results from the outer test specimens at the location *R*—½ in. show the water-quenched axle to have about the same elongation as the oil-quenched axle, 7 per cent greater elastic limit, 5 per cent greater tensile strength and 6 per cent greater reduction of area.

The test specimens from the middle of the wall show lower elastic limit and tensile strength than either the outer or inner test specimens, except that the strength of the water-quenched axle at the middle of the wall was found to be somewhat higher than in the outer specimens. It is evident that this mid-region of the section was less affected by the heat treatment. The water-quenched axle, however, shows higher elastic limit and tensile strength in this region than the oil-quenched axle, although, as already stated, the average strength of the entire section came out very closely the same for both.

The results obtained from test specimens from the inner surface of the wall are not so consistent; that is, they show a higher elastic limit and a lower tensile strength, elongation and reduction of area for the water-quenched axle.

All of the forgings tested meet the requirements of the specifications of the American Society for Testing Materials, except that the elastic limit found in the middle of the wall in the oil-quenched axle is somewhat low.

Table II—Chemical Composition of Specimens

Specimen Marks						
Water Quenched	Oil Quenched	Carbon. Per cent	Manganese. Per cent	Phosphorus. Per cent	Sulfur. Per cent	Silicon. Per cent
WA 4	....	0.53	0.56	0.019	0.031	0.159
WA 5	....	0.53	0.56	0.018	0.030	.....
WA 6	....	0.61	0.58	0.019	0.039	0.158
WE 4	....	0.53	0.56	0.019	0.030	0.162
WE 5	....	0.53	0.56	0.019	0.032	.....
WE 6	....	0.61	0.57	0.025	0.040	0.299
WD 3	....	0.62	0.57	0.023	0.042	0.176
....	*OA* 4	0.55	0.56	0.018	0.030	.....
....	*OA* 5	0.55	0.57	0.018	0.033	0.190
....	*OA* 6	0.63	0.59	0.019	0.041	0.195
....	*OE* 4	0.52	0.55	0.021	0.036	0.167
....	*OE* 5	0.54	0.56	0.019	0.031	0.182
....	*OE* 6	0.60	0.59	0.019	0.038	.....
....	*OD* 9	0.62	0.57	0.020	0.044	0.176

Table II gives the chemical analysis of representative test specimens taken from each axle. The water-quenched axle samples, taken from the *A* end, show that the outside and midway specimens *WA*4 and *WA*5 have the same carbon content, but when compared with analysis from specimen *WA*6 of the inner wall there appears a segregation of 15 per cent. The same is true of the samples taken from the opposite end of this axle.

In the oil-quenched axle also, the same segregated condition is present, the outer and middle test specimens having about the same carbon content, while the specimens *OA*6 and *OE*6, taken close to the inner surface, show a segregation of 14.5 and 11 per cent, respectively, when compared with the corresponding samples taken from the middle of the wall.

The segregation found in both of these axles indicates a condition which increases the difficulty of securing a satisfactory treatment of the forgings, and points to the desirability of including in all specifications for forgings which are to be heat treated, a clause to govern the allowable amount of segregation; otherwise it may be expected that extreme segregation will be found, as in the forgings here discussed.

THE USE OF PULVERIZED COAL AS A FUEL*

BY JOSEPH HARRINGTON

Powdered coal has been under consideration as a fuel for over 20 years, and its apparent advantages have attracted the attention of engineers throughout this time. During the past five years the use of this grade of fuel has come into active practice. In order for it to produce satisfactory results it has been found necessary to limit the percentage of moisture in the coal to one per cent as a maximum, not only for the sake of combustion efficiency, but for the sake of more perfect pulverization. The standard of pulverization has been established as follows: 85 per cent of the fuel must pass through a 200-mesh screen and 95 per cent must pass through a 100-mesh screen. Broadly speaking, the greater the volatile combustible content in the coal the more rapidly will it ignite and burn, and the less dependent will be this process upon the size and proportions of the combustion chamber. As the volatile content decreases, however, more dependence must be placed upon the proportions and location of the surrounding brick work in order to maintain the temperature until ignition is complete. Anthracite coal has been burned in a pulverized form, but it must be very finely ground, and must be burned in a rather confined space so that the ignition may be prompt, and aid rendered by nearby brick work during the period of early combustion.

Pulverizing Machinery. — Several types of machinery which are commercially marketed will satisfactorily pulverize coal. They are divided broadly into air separation machines and screen machines. In the former class there is an upward current of air produced by a fan which has a carrying capacity sufficient to take with it the finest particles, but which will not lift the coarser ones. These fine particles are deposited in a receiving tank by a cyclone separator.

The Burner.—It is now generally conceded that the most efficient results in burning powdered fuel are obtained when the coal dust is carried into the furnace in a stream of air, the volume of which is just sufficient to supply the oxygen necessary for its complete combustion. This mixture of coal and air must be made in fairly close proximity to the furnace. The reasons therefor are that when this mixing is done there is produced an explosive compound, which it is not desired should be of any greater extent than necessary. The velocity of the entering jet must be greater than the rate of flame propagation to prevent burning back into the pipe. The other reason for making the explosive mixture close to the furnace is that there is a tendency for the coal to separate and lose its uniformity of mixture, under which condition it is obvious that part of the jet would be oversupplied with coal and the other part oversupplied with air.

Objections and Difficulties.—Where a blowpipe effect of the powdered fuel flame is obtained, the heat of a high-velocity jet will melt out the brick work upon which it is impinged. Difficulty is also experienced by minute particles of the liquid slag being carried on in suspension and deposited upon the tube sheet or water tubes of the boiler, closing up the flame space and putting the boiler out of

*Abstract of a paper presented at the meeting of the Chicago Section of the American Society of Mechanical Engineers on May 15.

action. These defects are particularly noticeable with certain grades of coal.

Advantages.—From the viewpoint of the theorist, powdered coal is one of the most attractive propositions ever advanced for the promotion of combustion efficiency and commercial economy. There are in all transformations of energy unavoidable losses, and we are not possessed of apparatus which will gasify coal with 100 per cent efficiency. In the producer there is a string of losses which reduce the available heat in the gas to a considerable extent, and in the mechanical stoker there are unavoidable losses due to various forms of incomplete combustion. Only in the case of powdered coal is the actual solid fuel both gasified and completely consumed directly within the chamber desired to be heated. With perfect pulverization the entire mass is burned in suspension and in actual practice, but a small fraction of one per cent is actually lost in flue dust or slag pans. On account of the fuel being conveyed into the furnace by the very air which is afterwards to be used in its combustion, and on account of the diffusing of the coal throughout the air in a cloud-like formation, there is a possibility of a mixture which can be secured by no other means. Each particle of coal is surrounded by a particle of air, and on account of the extreme fineness of the particle practically complete oxidation occurs. The result is efficient combustion, and we have to deal only with the effects of the high temperature thereby obtained. It is now possible to control this temperature without sacrificing any material gain. Moreover, the definite control of the amount of air per unit of coal permits perfect variation in the results.

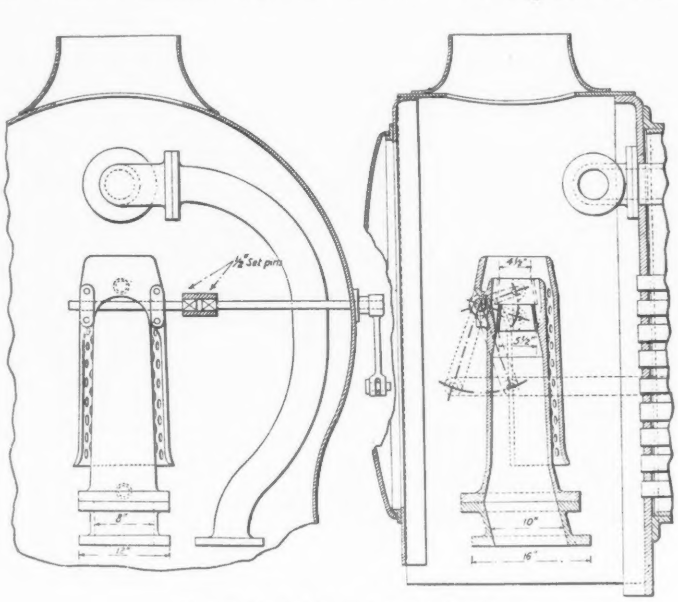
Stationary Practice.—Steam generation by the use of powdered coal as a fuel in stationary practice is still in the experimental stage, and herein, if anywhere, powdered coal will meet with severe competition. With the exception of the Missouri, Kansas & Texas installation at Parsons, Kan., which is now being put in by the Fuller Engineering Company, all of the steam-making installations are in the plants of manufacturers of powdered coal equipment, or in plants very directly connected therewith. That steam can be efficiently produced in this way is unquestioned, if the mere matter of combustion and evaporation is concerned. Whether it can be done more economically than is at the present time done by the best mechanical stokers will still remain to be commercially proved, and even with the powdered coal gas, analyses better than 16 per cent of CO_2 are not developed. With the mechanical stoker the CO_2 can be maintained around 14 per cent. With powdered coal the loss in the ash-pit and in the tubes does not exceed one per cent, and the best mechanical stokers will not exceed two per cent of the coal fired. A possible advantage in favor of powdered coal of two or three per cent in combustion efficiency is offset by the cost of fuel preparation. It is not reasonably to be anticipated that we can get better than 96 per cent efficiency, and this is a figure which can be obtained by the mechanical stoker.

Ash Fusibility.—A phase of the combustion problem is a study of the temperatures and conditions under which ash will melt. It has been found that coal ash will melt at temperatures between 2,200 and 2,700 deg. Furnace temperatures in commercial practice run between 1,800 and 2,800 deg., so that it is possible to secure coal, the ash from which will pass through the furnace without fusing. There is no hard and fast rule which can be stated for the selection of a coal. The temperature obtained in service, which is a function of the rate of combustion, the amount of excess air, and the proportions of the furnace chamber must be determined and an analysis of the fuel made to determine whether or not it will be suitable under the given conditions. In powdered coal work, with a more precise and scientific manner of the combustion process, the necessity for the proper knowledge of the fusing point of ash is greatly increased. The Commercial Testing and Engineering Company has determined that washing a dirty coal made no difference in the fusing point of the ash, so that mere ash content is not the determining factor of the desirability when considering a coal for pulverization. The importance of this preliminary investigation can scarcely be overestimated.

Conclusion.—Powdered coal is radically different in its physical structure and method of handling from any other form of coal hitherto commercially used. Having marked characteristics it will fit into certain cases with extreme acceptability and will probably prove just as undesirable in certain other cases. Probably the most important difference is the burning of the actual solid fuel directly within the chamber and in direct physical contact with the objects to be heated. There is, of course, an appreciable amount of incandescent carbon in the furnace at all times, and this solid fuel is emitting radiant heat in close proximity to the furnace content. A large amount of the radiant energy is therefore directly utilized, which is not the case with the gasification of coal in a detached chamber. I cannot but conclude, therefore, that the success of powdered coal lies in its adaptability to the special furnaces of the metallurgical field, and in those cases similar to the locomotive where there are other and weighty considerations in addition to the actual relative increase in combustion efficiency.

A VARIABLE EXHAUST NOZZLE

The British Board of Trade has been calling attention to the special need at the present time of economy in the use of fuel, and the possible savings by the use of variable exhaust nozzles has been more or less under discussion. A recent design of such a device is shown in the accompanying illustration. This exhaust nozzle is the invention of J. H. Jones, of Merthyr Tydfil, England, and it is claimed to materially reduce the deterioration of firebox sheets and tubes because of a more uniform draft on the fire. The engineman can



Jones Variable Exhaust Nozzle

regulate the draft from the cab by means of a rack having five or more notches so that the controlling lever can be fixed in any desired position. This results in obtaining what practically amounts to five nozzles of different sizes. No strong draft is necessary at any time and a considerable reduction in the amount of smoke given off results. The device also permits the use of a large size nozzle when starting, thus increasing the power of the engine when it is accelerating the train. A 25 per cent fuel economy is claimed as a result of the use of this type of nozzle.

Car Department

STEEL FRAME AUTOMOBILE CARS

The Wheeling & Lake Erie recently purchased from the Pressed Steel Car Company 200 automobile cars of the single sheathed type, with steel under and body framing. The underframe in itself is not intended to carry any load except in so far as it transfers the load distributed over the floor to the truss formed by the side framing of the car. The center sills are built to resist buffing only, consisting of 12-in. rolled channels weighing 35 lb. per foot, spaced 12⅞ in. back to back with the flanges turned outwardly and extending from end sill to end sill. They are tied together and reinforced at the top with a ¼-in. cover plate running their center and side sills. Each of these is reinforced at the top and bottom with 5-in. by ⅜-in. plates. The body bolster is of the box type, made of ¼-in. pressed diaphragms, located between the center and side sills and having a steel casting between the center sills with 14-in. by ½-in. top and 14-in. by 7/16-in. bottom cover plates. The floor is of 1¾-in. tongued and grooved yellow pine, resting on the side and center sills, and on two intermediate yellow pine stringers.

The side framing of these cars consists of an angle extending from end to end and forming the side plate, to which is riveted a 12-in. by ¼-in. plate extending from corner post to door post for use in attaching the side posts and braces, which are 3-in. 6.7-lb. rolled Z-bars. The door posts are

Wheeling & Lake Erie Steel Frame, Single Sheathed Automobile Car

whole length. The sills are located 2 ft. 4½ in. from rail to bottom of flange, under which condition they meet the M. C. B. requirements of area and ratio of stress to strain. The end sill arrangement consists of a heavy steel casting around the coupler opening forming the striking plate, with 10-in. rolled channels weighing 15 lb. per foot, extending between the striking plate and the side sills. They are tied to the side sills, which are also 10-in. 15-lb. rolled channels, with malleable iron push pockets. There are seven floor beams consisting of flanged diaphragms made of ¼-in. pressed steel, located between the center sills and between the 4-in. by 3½-in. by 5/16-in. rolled angles. These members, together with the side sill channel, form the carrying truss of the car. The siding is 1½-in. tongued and grooved yellow pine, bolted to the inside of the side frame members with ½-in. carriage bolts.

Each side of the car is provided with a 10-ft. door opening, equipped with double doors, so arranged that an opening of either 6 ft. or 10 ft. may be obtained. The center of the 10-ft. opening is 2 ft. 6 in. off the center of the car, the two centers are located diagonally opposite. The doors are made of yellow pine sheathing and framing 13/16 in. thick

and are equipped with Camel fixtures. It was believed that end doors were not necessary, the ends of the car are of solid steel construction of the Murphy type. These are riveted to rolled angle corner posts which are tied to the side sills with diagonal tie straps. Each end is provided with a flange at the top to form the end plate of the car and one at the bottom for riveting to the end sill. This bottom flange also supports the floor at the ends, making the car grain tight.

The roof is of the outside metal type, having rolled tee carlines. The inside measurements of the car are 8 ft. 6 in. by 9 ft. by 40 ft. 5 in., the height from rail to top of running board is 13 ft. 8⅞ in., the width over all is 9 ft. 11½ in., and the length over striking plates, 42 ft. ½ in. The cars are of 80,000-lb. capacity and weigh 42,600 lb.

The cars are equipped with the following specialties: Westinghouse air brakes, Sharon cast steel couplers, Carmer coupler release rigging, Imperial Appliance Company's coupler centering device and Miner friction draft gear with two-part cast steel yoke, having key attachment. The trucks are the Bettendorf type, having cast steel bolsters with Stucki side bearings, Barber lateral motion device, cast iron wheels, M. C. B. No. 2 brake beams and steel back brake shoes.

THE PASSENGER CAR TERMINAL YARD*

BY W. W. WARNER
Foreman Car Department, Erie Railroad, Cleveland, Ohio

The passenger car terminal repair yard answers about the same purpose for the car department as the roundhouse does for the locomotive department. It is a place where a very careful inspection is made of every visible part of the car, where all light repairs that can be completed in a few hours are made and supplies furnished for the next trip.

It is very important that the repair yard be located near the passenger station from which the trains depart; this saves excessive terminal expense. The layout should be such that the cars can be readily switched from either end. It frequently happens that at the last minute an additional car is ordered placed in the train, and this can be done in a short time if the yard is open at both ends. There should be plenty of track room and a liberal amount of space between tracks so that there will be no danger of personal injury to employees by cars moving on tracks adjacent to the one on which the employee is working. The location should also be such as will permit of a good drainage system. The yard should be planked or otherwise covered and kept clean.

The following facilities are quite necessary: A good water system, a good steam heat plant, a compressed air plant that will maintain a maximum pressure 24 hours a day, a drop pit for removing wheels and pedestals, a vacuum cleaning system for cleaning cushions, etc., and all the necessary tools and buildings, such as ice storage house, office, a storeroom for supplies, a small workshop for the carpenter and blacksmith work, and a room for the employees. These rooms should be equipped with individual lockers, a table for the use of the employees, and a place for them to wash up.

A good location and layout and the proper facilities mean much toward successful operation, but without a good live organization the desired results will not be obtained. First of all we must have a good live foreman who understands the operation from A to Z; a force of the very best car inspectors; the necessary number of good repair men; a good steam heat man; an air brake man who keeps up to date on the latest developments in passenger car brake equipment; an inside inspector who knows what is required and sees that it is done; a force of pipe fitters who can make all repairs to air, steam, signal, water and gas fixtures; an electrician, a carpenter (or more than one, if necessary), and a blacksmith and helper. The size of such an organization will depend, of course, upon the number of cars handled. The force should be capable of increase or decrease on short notice.

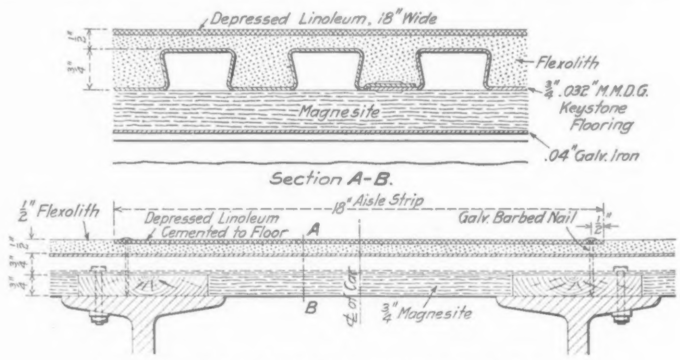
The first move of importance after a train arrives in the repair yard is a careful inspection to see if any repairs are necessary that will require that a car be switched out. The inspectors in charge of the steam heat should see that the steam heat system on the cars is properly drained to avoid freezing in cold weather. The air brake men should also look over the brake equipment to see if there are any defects that require their attention. Much depends upon the proper maintenance of the air brake. A very careful inspection of the brake rigging, trucks and draft rigging is necessary. The absence of one cotter may mean a car failure or possibly a derailment. The couplers should be gauged for height, and also for wear of the knuckle and lock to avoid break-in-twos. The journal boxes should be examined each trip. All of the interior appliances should be examined to see that they are in proper working order; the more important of these are the lighting system, the water system, the drips from sinks, basins, etc. The seats should be examined to see that they are not defective and that there are no projecting screws or other objects that might cause passengers to tear their clothes. The toilets should be thoroughly scrubbed and disinfected, the floors scrubbed and the seats dusted, preferably with a vacuum cleaner, the interior of the car wiped and the windows cleaned inside and out. The train should be made up as early as possible so that the air, steam and signal system can be tested for leaks so that any defects that might develop while the cars are being switched can be taken care of before the train is due to depart. There should be a specified time for the road engine to couple on and a record kept of the time the engine is actually coupled to each train. This will prompt engineers to get engines on the train on time.

The foreman, yard master and station master should keep in close touch with each other to prevent delays.

*Entered in the Car Terminal Competition.

DEPRESSED AISLE STRIPS

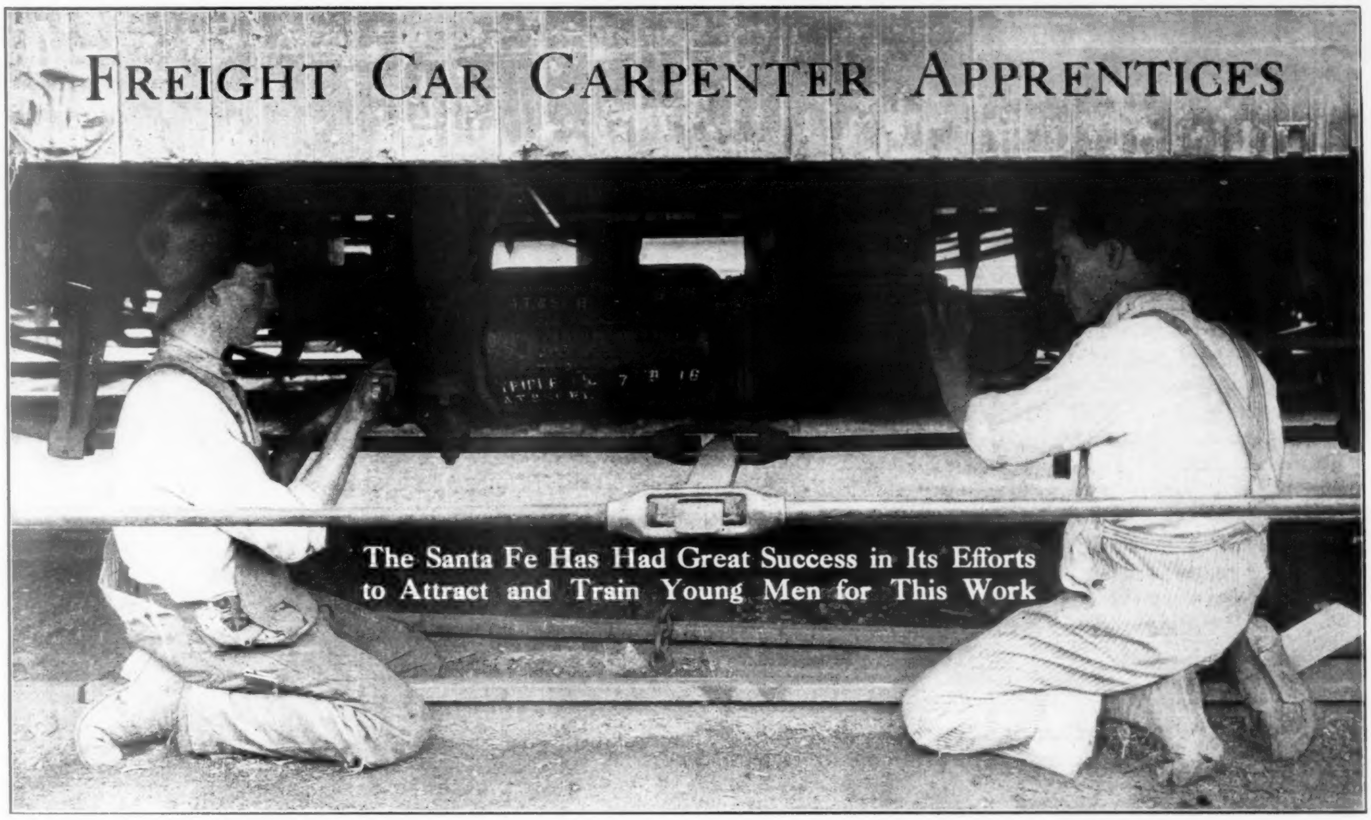
The Union Pacific is using depressed aisle strips in the floors of coaches and chair cars. The strip is linoleum, 18 in. wide and set in flush with the top of the Flexolith flooring. It is continuous, extending the full length of the passenger compartment. The linoleum is applied to the flooring with a heavy coat of linseed oil or a suitable cement, and is then securely tacked to the wood stringers over the center sills with small galvanized barbed nails. The linoleum used is ⅛ in.



Depressed Aisle Strip for Coaches and Chair Cars

thick, composed of inlaid alternate red and green blocks, 1 13/32 in. square or 2 in. diagonal. The blocks are laid diagonally and the strips are cut along the diagonal center line of the red blocks to form the edges for the sides to match the color of the Flexolith flooring. The use of the strips in this way is sanitary and also tends toward safety, as it prevents passengers from tripping over the edges of the strips.

A maroon coloring matter is mixed with the Flexolith flooring compound, which eliminates the frequent necessity of repainting floors.



Freight Car Apprentices on Air Brake Work

CAR department officers have found great difficulty in holding apprentices and in developing thorough courses of instruction for them. The Santa Fe started to provide adequate training for freight car carpenter apprentices about two years ago and, because of the results, has been encouraged to broaden the course very considerably. So important is this work regarded that a considerable part of the time of the annual conference of apprentice instructors*, which was held at Topeka in May, was given over to a discussion of its problems.

ADDRESS BY MR. SWANSON

C. N. Swanson, superintendent of the car shops at Topeka, spoke to the apprentice instructors concerning freight car carpenter apprentices. Among other things he said: There is one word that is uppermost in the minds of the American people today, and that is "preparedness." The government is just awakening to the fact that it must prepare. The Santa Fe woke up several years ago and started the apprentice system to prepare the men who are to run it in the future. This organization is like one big cog wheel, each one of us being a cog in the wheel. The man who works on draw-bars of the cars is as necessary a part of this organization as any of the higher officers. The part the freight car carpenter plays is to prepare a vehicle to haul the one thing a railroad has to sell—transportation. There are many who do not thoroughly appreciate the importance of freight cars, but when it is considered that thousands and thousands of dollars are spent for loss and damage due to defective equipment, the importance of the car repair man becomes apparent. A small defect, such as leaky construction, often means considerable money spent in claims, all of which means that a job worth doing is worth doing right. Don't turn these cars off the repair track, expecting the next division point to take them and repair some part that you left undone.

It is necessary for the apprentice instructors to use discretion in placing the boys in the different gangs. It is good practice to bunch the more advanced boys together, rather than to have one of the gang hold them back in their work, which is at best discouraging. Those boys who started their apprentice course some time ago have been placed in gangs on what is called the heavy side, rebuilding cars from the ground up, and the men in the gangs are very much pleased with the work they do. Care must be taken in selecting the boys when they apply for an apprenticeship. It is highly desirable to have as large a waiting list of prospective apprentices as possible in order to keep the apprentice ranks full at all times.

Following Mr. Swanson, David Hurley, general foreman of the freight car shops at Topeka, gave a brief talk, testifying to the good work being done by his freight car apprentices, particularly those who had been in service a year or more. He said that the present method was far superior to the former method of recruiting and training freight car carpenters by the student system.

CAR INSPECTION

H. L. Shipman, general equipment inspector of the Santa Fe, gave a talk on Overhead and Terminal Inspection, at the Thursday afternoon session. He called attention to the important defects met with in car inspection, speaking particularly on the necessity of proper inspection of car roofs and doors and draft rigging. He showed samples of defective car brasses which caused hot journals. In some of the journal boxes having the six or four-pocket type wedges, the ribs on the wedge will cut into the box, so that in time the wedge will bear solid on the box and have no opportunity for rocking when a suddenly applied pressure, such as caused by the butting of two cars together, is applied to the brass by the journal. This very often results in a broken lining in the brass which will in time work down the side of the brass, giving an uneven bearing and causing the journal to run hot. Brasses defective in this way can be located only

*An account of the general problems which were discussed at this conference will be found in the *Railway Mechanical Engineer* of July, page 363.

by feeling the brass to determine whether or not the lining is working out.

APPLICANTS FOR FREIGHT CAR APPRENTICESHIP

J. A. Daughtie, apprentice instructor in the freight car shop at Cleburne, Tex., presided over the discussion of this subject. It was unanimously agreed that each applicant should be examined both by the school instructor and the shop instructor. It was believed that any young man who was old enough to be an apprentice, who had not learned to add, subtract, multiply and divide, and handle simple fractions, was lacking in either mentality or ambition, and in either case would be unlikely to make good as an apprentice.

At some shops good results had been obtained by choosing boys already employed in the shop, some of these coming from labor gangs. Most of the instructors, however, reported that they had not obtained very good results from young men selected from the labor gang. In general no difficulty had been found in obtaining a sufficient number of good applicants. The instructor, by letting the other boys and men in the shop know that there was an opening for an apprentice in this trade, usually received a number of applications from which he could select the most promising young man. It was agreed by all that the best way to secure good applicants was to see that the apprentices already employed were given every possible opportunity to learn the work; and that these boys who were well satisfied with the work would be the best advertisements the company could have in attracting other suitable material. A boy from a nearby small town usually brought a number of other applications from the same place; these are usually found to be good material.

Owing to the higher rate paid and the older age at which applicants are employed in this trade it is to be expected that a larger percentage will drop out in the early months of their apprenticeship, as some of them come wishing a job rather than a trade and leave when something more remunerative shows up. The instructors, however, by exercising care in the selection can reduce such cases to a minimum. It has been found that most of the men who drop out do so during the probationary period. Each shop should keep a waiting list of applicants for this trade the same as for other trades and those shops having a surplus of applicants should find out if the young men making application would be willing to go to other shops where they may receive employment at once.

SCHEDULE FOR FREIGHT CAR APPRENTICES

W. H. Heins, apprentice instructor at the freight car shop, Albuquerque, N. Mex., presided. The work of training men for the car department was started about two years ago, and as the course is 2½ years, none of the apprentices have been graduated. Each apprentice is assigned to various classes of work as follows:

Truck work	2 months
Wheel shop, inspection of wheel and axle defects	1 month
Draft rigging couplers, etc	1 month
Body, framing and light repairs	6 months
Steel work	3 months
Planing mill, laying out work	1 month
Car roofs, doors and interior work	2 months
Heavy repairs	9 months
Air work in air room	1 month
Air work, repairs to cars on repair track	2 months
Car inspecting	2 months
Total	30 months or 2½ yrs.

It is not intended that this schedule be followed to the letter at all points as local conditions may necessitate certain changes, but it should be used as a guide and adhered to as closely as possible. The value of each class of work mentioned was pointed out and all instructors were urged to leave nothing undone toward preparing the freight car apprentices so that they may be fitted to do any class of work which arises in the freight car shop.

During the discussion particular stress was laid upon the necessity of giving the apprentices ample instruction in car inspection.

Freight Car Apprentices Fitting Up an End Sill

SHOULD FREIGHT CAR APPRENTICES WORK WITH JOURNEYMEN?

Peter Dahlstrom, apprentice instructor in the freight car shop at Topeka, acted as chairman. It seemed to be the general opinion that better results will be secured if the apprentices work in apprentice gangs rather than with journeymen, especially during the first year or year and a half of their apprenticeship. Apprentices should be grouped according to their ability and progress, care being taken not to hold back any of the older and more experienced boys because of the slowness or lack of experience of some younger or inferior boy. As the apprentices became more experienced and skilled they may be worked to good advantage

with journeymen, especially during the last year of their apprenticeship. This has been tried out with a number of the older boys at Topeka and their work has been so satisfactory that the journeymen were glad to have them with them. But in the earlier stages of the apprenticeship all agreed that the best results could be obtained from working the apprentices in apprentice gangs under the supervision of the apprentice instructor.

INSTRUCTIONS IN THE M. C. B. RULES

J. E. Saunders, apprentice instructor at Shopton, Iowa, acted as chairman. It was pointed out that the best way the apprentices can learn the M. C. B. rules is to have the instruction take place while they are doing the repair work. There is a possibility of correlating the work with the school instruction to good advantage. Mr. Swanson believed that it would be far better to take the boys to the repair tracks, explain the work being done and show them the rules governing these repairs. Particular stress should be laid on the important rules, which should be given out for study; the boys should be examined on them at the next school meeting. It is highly desirable to have the shop instructors attend the school classes with the boys in order that the practical problems may be discussed and the instructors may be sure that they are thoroughly understood.

Freight Car Apprentice Repairing a Car Roof

FREIGHT CAR WORK FOR COACH CARPENTER APPRENTICES

Frank Meyers, apprentice instructor in the freight car shop at Topeka, acted as chairman. The question at issue was whether or not the passenger car apprentices who are required to serve four years should be required to spend some time on freight car work. This has been tried in some cases, but it was found that as a rule the boys object to being required to do freight car work, feeling satisfied to restrict their field of endeavor to passenger cars. However, it was pointed out that if competent car foremen are to be made of these boys some experience in the freight car work is necessary, as this is the largest field in the car department and cannot be overlooked. The experience obtained by the boys, also, will permit of shifting them from passenger to freight work, in case of sudden demand for skilled work on freight cars. With the experience from working on the passenger cars it was believed that the freight work would come easily to the boys, and that six months would be sufficient to give them a proper idea as to how the work should be handled.

SCHOOL ROOM INSTRUCTION FOR FREIGHT CAR APPRENTICES

C. B. Falkenstein, apprentice instructor at San Bernardino, Cal., acted as chairman. As the schedule for freight car apprentices now stands one hour a week is allowed for school room instruction. It was believed that more time should be given the boys in the school room, and that in addition to the M. C. B. rules they should be instructed in free hand sketching, a sufficient amount of arithmetic to properly compute dimensions and fill out car bills, some mechanical drawing and reading of blue prints, together with information concerning the relative cost of the material they have to handle. It would be possible also to advance the new apprentices in learning the fundamentals of car construction.

QUESTIONS FOR FREIGHT CAR APPRENTICES

H. E. Ralston, apprentice instructor in the freight car shop at San Bernardino, Cal., presided. In connection with this subject Mr. Thomas distributed a new list of questions for freight car carpenter apprentices, on which they should be examined before they are graduated from the course. There were 202 questions in all, a few of which are given below as an indication of what is expected of a graduate freight car carpenter apprentice.

30. What are the M. C. B. rules regarding the mating of wheels on axles?
31. What is the minimum thickness of a flange on wheels of a 60,000 lb. capacity car? Of a 100,000 lb. capacity car?
32. What is the cause of slid flat wheels?
33. What is the cause of cracked plates?
34. What are the indications of a loose wheel?
35. How should a pair of wheels be gaged?
36. Why may mounted wheels be full gage at one point and shy at another?
37. What are the more common wheel defects?
38. If a car wheel has vertical flange, is it safe to leave it under the car?
39. How are car wheels applied to axles?
40. What size should shelled out spots be on a wheel before the wheel should be condemned?

These questions are used for instruction and not as a means of "throwing" an apprentice.

THE NEED OF UNIFORM EQUIPMENT ON FREIGHT CARS*

BY H. W. BAYLISS

While this subject is a general one, it is also one that merits deep thought. Knowing the trouble and delay occasioned because of the use of such a great variety of attachments on freight cars, I feel that there should be something said, as a forerunner for something being done to create more uniformity. Uniformity should be encouraged, from an economical standpoint alone. A few years ago the Master Car Builders' Association appointed a coupler committee to experiment and work out a standard coupler which would be interchangeable, irrespective of the manufacturer. There is a good deal of unwarranted expense entailed by the different railroads in the adoption of the many types of couplers and parts, and also operating attachments.

We should not leave the subject of a standard coupler without calling attention to the varied designs of coupler rear attachments we have in use. We have the twin spring rigging, the tandem spring attachment and numerous types of friction gear. While it may not be possible to bring about a uniformity of parts with respect to the rear attachments, it would seem that there is need for some standardization of them to avoid the necessity of carrying a large stock of this material and also to facilitate repairs.

Concerning the operating devices, of which there are many

*From a paper read at the June meeting of the Niagara Frontier Car Men's Association, Buffalo, N. Y.

of various designs, we have a great need for uniformity of equipment, as the multiplicity of designs makes it almost impossible to keep a stock on hand to meet all contingencies.

In the case of trucks, there are quite a number of different kinds and when we call to mind that this is a part of the equipment that means much for the safe movement of a car, I believe that we should put forth our best efforts to bring about a standard type or design.

The all-important matter of United States Safety Appliances calls for more uniformity of practice, not so much in the manner of application as in the design of the parts. Some roads elaborate more on these parts than others, in that the ladder treads are all manufactured with a foot guard and they are also of heavier iron. I notice also that there is quite a variety of sill steps and it is my belief that whatever is best should be adopted and thus create more uniformity of practice.

While I have referred to certain parts or attachments in setting forth my views, there are other attachments that come within this scope.

SEVENTY-TON GONDOLA CARS

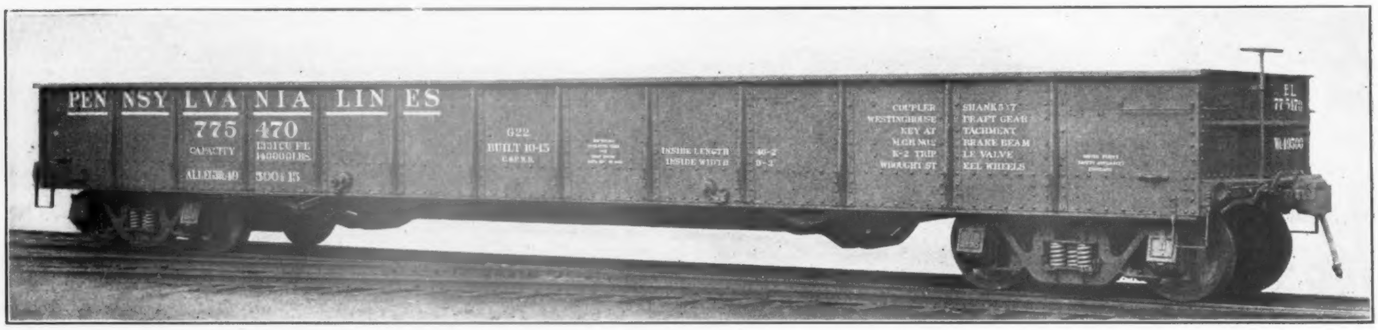
The Pennsylvania Railroad recently received from the Pressed Steel Car Company 2,000 gondola cars of 140,000 lb. capacity and weighing 49,500 lb. These have, in addition to the high carrying capacity mentioned, a great inside length and a short distance from rail to top of floor. Provision is made for the usual 10 per cent overload, and the design is such that heavy concentrated loads can be taken care of. There are two heavy crossbearers in the underframe, designed to make the side girders and center sills work togther. The height of the sides is only 3 ft., and the top of the sides is reinforced with special heavy bulb angles, 5 in. by 4½ in. by 1½ in. by 7/16 in. Four small hoppers are provided in the floor, each equipped with 2 doors. The doors are operated in multiples of four, with either the Lind or Simonton door operating device. The distance from rail to top of floor is only 3 ft. 4¾ in., which keeps down the height from the rail to the center of gravity of the loaded car. Excessive height may easily be the cause of derailment.

The inside length is 46 ft. 2½ in. The sides are equipped inside with collapsible stake pockets. These are out of the way when not in use and are, therefore, less liable to be damaged by the lading.

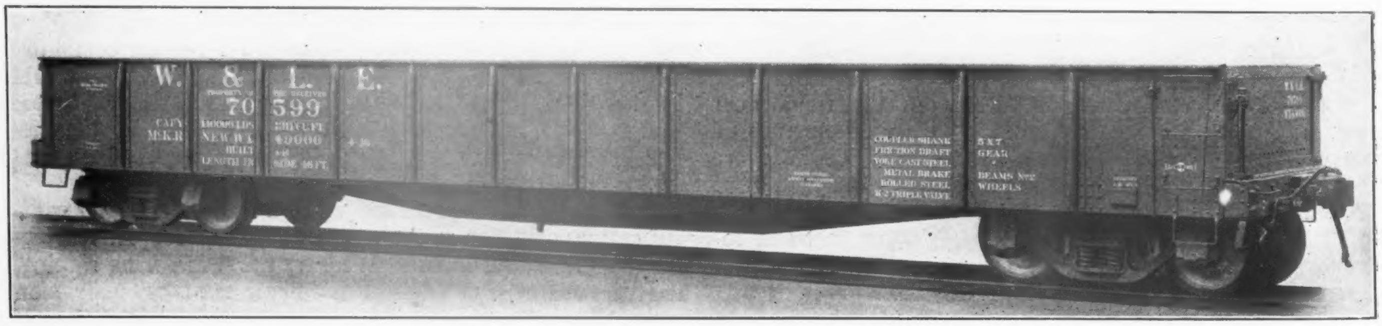
Pressed steel is largely used throughout. Some structural shapes are incorporated where they can be used to advantage, but such items as center sills, bolster diaphragms, floor beams, end sills, end braces, side stakes, hopper sheets, drop doors, etc., are made of shapes pressed out of steel plates. The plates forming the floor, side and end sheets, doors, hopper sheets and most of the floor beams are made of ¼ in. material. The center sills are 24 in. deep, made from a 7/16-in. plate, flanged top and bottom, and extending from end sill to end sill and are reinforced at the top with a ⅜-in. plate and at the bottom with a 4-in. by 4-in. by ¾-in. angle. The body bolster is made of 5/16-in. plate reinforced at the top and bottom with ½-in. plates. The member forming the bottom chord of the side girder is made of a 4-in. by 4-in. by ⅝-in. angle, and the side is stiffened and held in place with 12 stakes made from 5/16-in. plates. The length of the car from center to center of couplers is 50 ft., and the over-all width is 10 ft.

The trucks have cast steel side frames which are tied together with pressed steel spring plank channels made of 9/16-in. material. Rolled steel wheels, open hearth steel axles and pressed steel journal boxes are used, the journals being 6 in. by 11 in. The bolsters are pressed steel and the brake beams are M. C. B. No. 2.

A freight car of the flat bottom gondola type, having a wood floor, but otherwise entirely of steel, has its advantages, inasmuch as the sides may be used as girders for carrying the load along with the center sills, which does away with the necessity of deep fishbelly side sills. In other words, the sides serve a two-fold purpose which is not possible with the low side composite car in which the sides are made of heavy planks and which condition requires deep side sills or much heavier and deeper center sills with cantilever floor beams. The use of a wood floor in a car of this type retains the advantages of ability to secure and brace the lading. Where steel sheets are used for the sides a further advantage over the cars having wood side planks is obtained in an increase in



Seventy-Ton Gondola for the Pennsylvania Lines

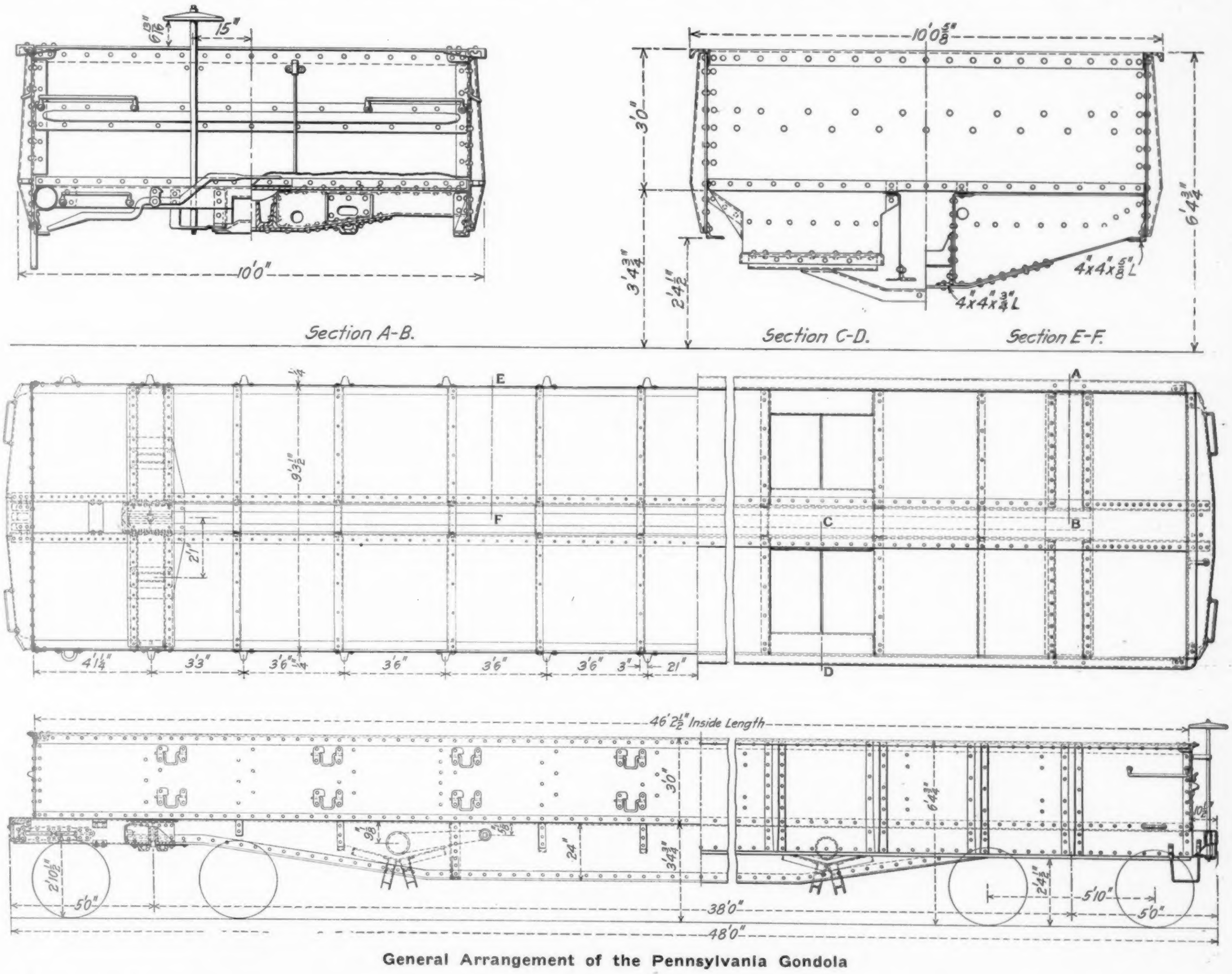


Seventy-Ton Gondola for the Wheeling & Lake Erie

cubic capacity on account of being able to make the car from 6 in. to 7 in. wider inside and still maintain the same over-all width. The floor of a low side car of this type, intended for heavy and concentrated loads, must necessarily be ample in thickness and well supported.

The Pressed Steel Car Company recently completed an order of such cars for the Wheeling & Lake Erie. The cars are of 140,000-lb. capacity and designed to carry a concentrated load of 100,000 lb. at the center. The clear length inside is 45 ft. 6 in. and the width inside of side sheets is 9 ft. 6 in. The height from floor to top of sides is 3 ft. The floor is of yellow pine 2⅞ in. thick and rests directly on the center sill cover plate, an angle riveted to the sides and intermediate yellow pine stringers 4 in. by 4 in. in cross section. The

The center sills of these cars are of the fishbelly type, 30 in. deep at the center and 12 in. deep at the bolster and end, and are continuous without splices from end sill to end sill. Each sill consists of a ⅜-in. web plate, reinforced at the top with a 3½-in. by 3½-in. by ⅜-in. angle on the outside and at the bottom with two 4-in. by 3½-in. by 7/16-in. angles. The two sills are tied together at the top with a 25-in by ¼-in. cover plate extending from end sill cover plate to end sill cover plate. This center sill cover plate is made extra wide to extend several inches beyond the center sill top angles, in order to provide space for securing the floor without the necessity of passing the floor bolts through the center sill top angle. The girder formed by the sides is 4 ft. 3⅛ in. deep and is reinforced at the top with a 4-in. by 3½-in. by



General Arrangement of the Pennsylvania Gondola

height from the rail to the top of the floor is 3 ft. 7⅝ in. Each end of the car is provided with a special design of steel drop end gate which may be lowered to the floor of the car when hauling long material requiring twin loading. This end gate is made of ¼-in. steel, stiffened transversely with three braces. The braces at the top and bottom are integral with the plate, it being bent in and around on itself, the flange riveted to the face, thus forming a hollow beam about 3 in. deep for the whole length of the gate. The other brace is a separate pressed steel piece and is riveted to the face of the sheet at the center. The ends of the gate are further stiffened by a vertical pressed brace riveted to each end. All the braces are on the inside, so that the end presents a flat surface on the outside. The inside of the car is equipped with 32 collapsible stake pockets.

1½-in. by ½-in. bulb angle and at the bottom with a 4-in. by 3½-in. by ½-in. plain angle. Each side is secured against bulging and stiffened with 12 pressed steel stakes made from 5/16-in. plate, each of which is located in line with either diaphragms, crossbearers or the body bolster. There are 4 crossbearers to effectively connect the side girders and center sills and to insure the proper distribution of stresses for all manner of loading. Besides these crossbearers there are 6 floor beams on each side of the car. The crossbearer diaphrams are made of 5/16-in. steel, the floor beams of ¼-in. steel and the bolster diaphragms of ⅜-in. steel. These members are pressed from a plate to provide continuous flanges all around. The bolster top and bottom plates are 14 in. by ⅝ in. The end sill consists of a 12-in. rolled channel and is reinforced at the top with a 19-in. by

¼-in. plate and a 5-in. by 3½-in. by 7/16-in. angle, extending from side to side, the latter forming a bottom stop for the drop end gate.

The Wheeling & Lake Erie cars are equipped with Miner friction draft gear, Sharon couplers, Imperial Appliance Company's coupler centering device, Stucki side bearings, Westinghouse air brakes and Blackall drop handle brake ratchet. The trucks are of the cast steel Bettendorf type with cast steel bolsters, steel wheels and M. C. B. brake beams. The length of the car over striking plates is 48 ft. and the weight is 49,000 lb.

PRESERVING THE LIFE OF STEEL CARS

BY H. M. CLARENCE

A very large share of the corrosion and decay of the steel car surface comes, in the main, from a lack of that protection which good paint and varnish affords. One need not be an expert in the technical features of painting or of chemistry to prove this. The layman may easily note that plain surfaces which are subject to the same service conditions as any other part of the car are almost without exception in a better condition than certain other parts which are less easily kept under an adequate coating of paint and varnish. It has been noted that the deck or clerestory of the car, the window sills and the parts immediately about the window sash, in and around which the moisture enters and lies, are prone, under the same measure of protection given the plain surface, to "fissure" and throw off the finish as the layers of rust and corrosion develop. This condition supplies the proof that the right sort of painting and varnishing is the protection which the steel surface must have in order to have a reasonable length of life and a good appearance.

Granting that the car as it comes from the builder has an ample and effective covering of paint and varnish, what is the treatment which it should receive, consistent with its value? We have been told in conventions and elsewhere, that the varnish should under reasonable treatment last for eight, nine, ten and even twelve months, and under the best care, some time longer than this. It is sound car economy, however, to apply varnish often enough to avoid straining the varnish, which is done when the shopping is postponed until the varnish is worn thin and thereby becomes less capable of withstanding the wear of service. The steel car has been long enough in use to show that a procrastinating policy in respect to the renewal of the paint and varnish is poor economy. If railway managements could arrange, without seriously interfering with traffic, to shop the steel passenger car twice a year for such paint and varnish renewals as the master car painter finds it necessary to make, the difficulties of premature corrosion, it is fair to believe, would be in large part satisfactorily settled. The surfaces most freely attacked by moisture and affected by corrosion could then be taken care of, both by the removal of the rust already present and the covering of the parts thus affected with paint as nearly rust-proof as can be obtained. All such surfaces require at these shoppings not one coat only, regardless of condition, but as many more, all carefully applied, as the condition of the old paint and the metal need to protect them beneath the finish. Varnish color or enamel should top off the primary coats and round out a finish capable of holding against all kinds of service. Over all will then be needed a covering of varnish. It is a matter of some speculation as to just how many coats of varnish will best answer the requirements. Probably the great majority of railroads employ two coats of finishing varnish for all passenger equipment cars, but the three coats usually given private cars, dining cars and other equipment of this order, bear out the assumption that three coats of varnish applied at each shopping will give a proportionately longer service, and during that service give a much better appearance to the car, with its resultant advertising possibilities. A well-finished car is a continuous advertisement. Good facilities for comfort inside of the car have a value which all recognize, but the outside tells the story of the prosperity of its owners and the refinements which they are pleased to extend to the traveling public. The way that travelers dash for the best looking car in the train shows the advertising advantages of good outside finish.

The exposed underside of the floor is a part of the steel car which needs treatment at each shopping. This is a part of the passenger car which it is natural to pass without much attention. The inference sometimes is that the grease and foreign accumulations massed upon this space are in themselves an adequate protection, but investigation of such surfaces following any considerable period of service, unless they have been regularly and carefully painted, will disclose a corrosive condition requiring little short of heroic treatment to correct. The writer has examined corrugated steel express car floors which show patches of surface literally eaten through. If given thorough attention at the regular shopping of the car such destructive conditions could hardly be expected. All these parts of the car should have the grease and dirt removed, and as much of the rust and decay started loose and brushed away as is possible under the circumstances. Then with plenty of good paint worked into every crevice of the floor you will have a very essential part of the car properly taken care of. Eternal vigilance is indeed the price which paint shop protection of the steel car exacts. Without it, corrosion and premature decay are rampant. Thorough painting of all parts, with plenty of varnish where needed, is essential to maximum life and beauty.

SHRINKAGE OF BOX CAR SHEATHING

Several roads which are extensive users of single-sheathed outside steel frame box cars have had difficulty due to the shrinkage of the sheathing after it is placed on the cars and the cars are in service. This was due to insufficient drying of the lumber before application. The slotted holes generally used to take care of adjustments for overcoming the effects of such shrinkage provide only ⅝-in. or ¾-in. which it will be seen is entirely inadequate when we consider that in one order of automobile cars there was a shrinkage in a height of 10 ft. of from 5½ in. to 7½ in. These cars were built without specification being made as to the dryness of the lumber and in the next order of cars special care was taken to provide well dried lumber. Samples measuring approximately 1½ in. by 5 in. by 12 in. were placed for a period of 96 consecutive hours in a hot cupboard, the temperature being maintained at from 160 deg. F. to 180 deg. F. Any of the tested pieces which showed a reduction in weight of more than six per cent were considered improperly dried. It was found, however, that the long period of drying was inconvenient and very short samples of the same lumber were tested in various ways to determine on the shortest practicable time of drying. As a result of these tests the specifications for dryness required all samples to be taken from the middle portion of the stick. These samples are from ¼ in. to 5-16 in. long and are dried for two hours in a hot cupboard at the temperature previously used. A shrinkage of more than 1-16 in. in a width of 3¼ in. is taken as indication that the lumber is improperly dried. In view of the trouble that has been experienced by some roads this means of obtaining properly dried lumber for horizontally sheathed box cars should prove of value to any road considering the construction of this type of car. The cars as built under the first method referred to have proved entirely satisfactory and while no cars have as yet been built to the second specification, officers of the railway which has developed this method feel entirely confident that it will give as good results as the previous specification.

Buffing Stresses in Box Cars

A Stress Analysis Which Includes the Horizontal Effect of Inertia Upon Body Frame Members

BY ROBERT N. MILLER

I.

The conditions which necessitate heavy and frequent repairs to freight cars are the use of defective material in construction and excessive stresses in the frame members and joints. The latter condition may be due either to faulty design or to rough and unfair usage. The proper limiting of the stresses in frame members is thus of vital importance to the life of the equipment and since unfair usage exists, the designer must provide for it.

From observations as to the nature of repairs made in repair yards as well as from dynamometer records obtained in road and yard service it has been noted that quite common switching practice involves the making of couplings at speeds of from five to ten miles per hour and that these speeds are checked in about six inches of total car movement either through draft gear resistance, impact or both. On this basis the following method of stress analysis employing both analytical and graphic methods has been developed and applied to box car design.

Every moving body by virtue of its velocity, may be considered a storehouse of kinetic energy and it is when this energy must be rapidly dissipated that the intensity of the retarding force is realized. Owing to the characteristics of the various friction draft gears now on the market this retardation is not of a uniform nature but increases more or less rapidly as the draft gears are compressed, giving a maximum retarding force of approximately twice the mean. Based upon this assumption, where

V_1 = Speed of approaching car in miles per hour,
V_2 = Speed of car after impact,
S = Distance in feet in which speed is checked,
f = The average retardation in space S, in ft. per sec., per sec.,
P = Average retarding force acting on W pounds of moving weight,
g = Acceleration due to gravity = 32.2,

then $f = \dfrac{(V_1^2 - V_2^2)}{2\,S} \times \left(\dfrac{5{,}280}{60 \times 60}\right)^2 = \dfrac{(V_1^2 - V_2^2)}{S} \times 1.075$

and $P_1 = \dfrac{Wf}{g} = \dfrac{1.075}{32.2} \times W \times \dfrac{(V_1^2 - V_2^2)}{S}$

$$\text{or } P_1 = 0.0337\ W \times \frac{(V_1^2 - V_2^2)}{S} \quad \ldots\ldots (1)$$

The maximum retarding force, $P_{max} = 2\ P_1$

$$P_{max} = 0.0674\ W \times \frac{(V_1^2 - V_2^2)}{S} \quad \ldots\ldots (2)$$

Assuming an initial velocity of 10 miles per hour, and that the car is brought to rest in a distance of 6 in., $V_1=10$, $V_2=0$ and $S=0.5$. Substituting these values in formulas (1) and (2):

$$P_1 = 0.0337\ \frac{W \times (10)^2}{0.5} = 6.74\ W \quad \ldots\ldots (3)$$

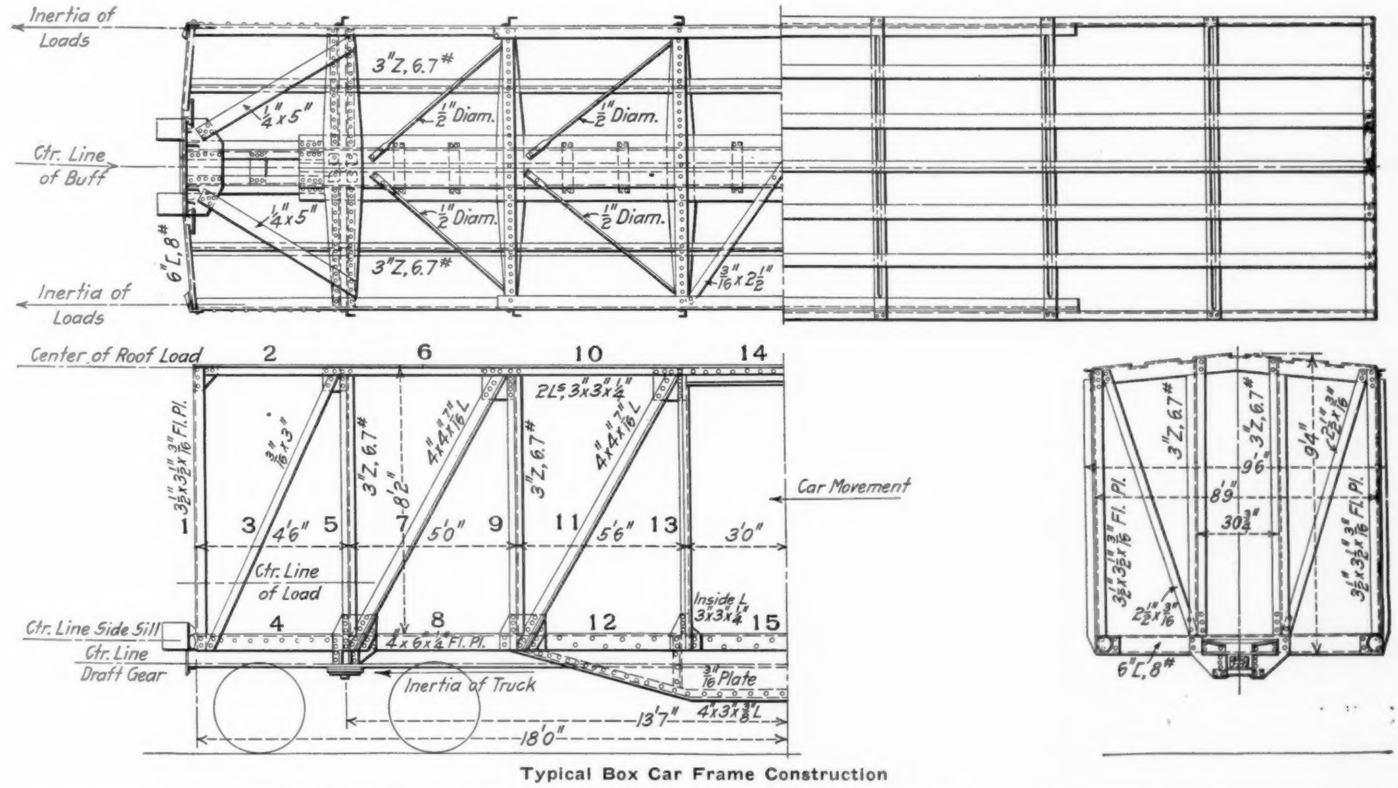
$$P_{max} = 2\ P_1 = 13.48\ W \quad \ldots\ldots (4)$$

The numerical factor which multiplied by the weight of the moving body gives the maximum retarding force may be represented by *K* and formula (2) then becomes:

$$P_{max} = K\ W \quad \ldots\ldots (5)$$

At the moment of impact the moving car can be considered as subject to two loads: (1) Static load, due to its own weight plus the weight of lading, acting vertically downward; and (2) dynamic load, due to the inertia of the various parts making up the car body and lading, acting horizontally. The maximum stress in each member of the car framing is the resultant of these two loads.

In order to make proper distribution of the static and inertia loads it is essential that the weights of the various parts or members of the moving body be determined either by estimate or actual weight. Since analyses of this nature



Typical Box Car Frame Construction

are generally made in the preparation of new designs, the greater portion of the weights can be considered as estimated. While the following discussion is general in nature and may be applied in principle to any type of box car construction, a type of box car now in service, the construction of which is shown in the drawing, has been chosen for the purposes of illustration. This car has a capacity of 80,000 lb. and weighs light, 39,000 lb. The following table gives the dimensions of the car body and an estimated analysis of weight distribution:

Trucks (cast steel side frame)	15,000 lb.
Underframe, flooring and brake rigging	9,600 lb.
Side framing and sheathing	7,700 lb.
Roof framing and roofing	4,200 lb.
End framing and sheathing	1,400 lb.
L = length of car body in inches	432
b = width of car body in inches	102
h = height of car body in inches	100

W_r = average weight of roofing and roof framing per sq. ft. (taken at 14 lb.).
W_s = average weight of side frame and sheathing per sq. ft.
W_e = average weight of end frame and sheathing per sq. ft.
N_r = number of roof panels.

ROOF

Static or Vertical Load Stresses.—That portion of car body weight shown as roof load can be considered as borne directly by the purline members and transferred to the side frame top chord member through the carlines. For simplification the total roof load to the carlines can be considered as uniformly distributed over the carline length and for all except the end carlines can be placed equal to

$$\frac{W_r \times b\,L}{N_r \times 144} = \frac{\text{Total roof load}}{\text{Number of roof panels}} = \text{Roof panel load} = P_r$$

resulting in a maximum vertical bending moment at the center of the carline of

$$P_r \times \frac{b}{8} = M_{rv} \quad\text{.......... (6)}$$

The corresponding fibre stress in the carline will be equal to

$$S_{rv} = M_{rv} \div Z_v \quad\text{.......... (7)}$$

where Z_v = the section modulus with neutral axis horizontal.

The shear in the carline member at the side frame is given as

$$S_{srv} = P_r \div (2 \times \text{net area of carline}) \quad\text{.......... (8)}$$

Where the end framing extends from the underframe to the end carline, the vertical bending in the end carline or end plate can be considered as resisted by the vertical end members through their column action. In some box car designs adapted to automobile service the end carline or end plate at the door end of the car must be considered as unsupported in the center against vertical bending, in which case the maximum fibre stress due to vertical bending is

$$S^1_{rv} = \frac{P_r \times b}{16} \div Z_v \quad\text{.......... (9)}$$

and the corresponding shear at side frame connection is

$$S^1_{srv} = P_r \div (4 \times \text{net area of end carline}) \quad\text{.......... (10)}$$

Inertia or Horizontal Load Stresses.—From equation (5) it can be seen that the inertia load bears a definite ratio to the static load and it is evident that the section modulus resisting horizontal bending in the carlines must be K times that resisting vertical bending. The stress in carlines resulting from the inertia load is therefore

$$S_{rv} = K\,M_{rv} \div Z_h \quad\text{.......... (7a)}$$

where Zh=the section modulus resisting bending with neutral axis vertical. The corresponding shear at the side frame connection due to this inertia load is

$$S_{srh} = K\,P_r \div (2 \times \text{net area of carline}) \quad\text{.......... (8a)}$$

Likewise the fibre stress in the end carline member due to inertia is

$$S^1_{rh} = \frac{K\,P_r \times b}{16} \div Z_h \quad\text{.......... (9a)}$$

and the shear at side frame connection

$$S^1_{srh} = K\,P_r \div (4 \times \text{net area of end carline}) \quad\text{.......... (10a)}$$

Whereby upon combining (7) and (7a) the maximum fibre stress in the carline is found to be

$$S_{r\,max} = S_{rh} + S_{rv} = M_{rv}\left(\frac{1}{Z_v} + \frac{K}{Z_h}\right)$$
$$= \frac{P_r \times b}{8}\left(\frac{1}{Z_v} + \frac{K}{Z_h}\right) \quad\text{.......... (11)}$$

If the carline connection to the side rail be of a gusset type, then under horizontal inertia loads the fibre stress in the carline due to the inertia of the roof load is

$$S_{rv} = \frac{K\,M_{rv}}{1.5} \div Z_h \quad\text{.......... (7b)}$$

and the maximum combined fibre stress due to the static and inertia loads is

$$S_{r\,max} = M_{rv}\left(\frac{0.67\,K}{Z_h} + \frac{1}{Z_v}\right) \quad\text{.......... (11a)}$$

The maximum shear corresponding to the above maximum bending moment is

$$S_{sr\,max} = \sqrt{(S_{srv})^2 + (S_{srh})^2}$$
$$= \left[\frac{P_r}{2 \times \text{net area of carline}}\right] \times \sqrt{1 + (K)^2} \quad\text{.......... (12)}$$

The maximum stresses in the end plate are given in connection with those for end framing.

Equations (7) and (7a) can also be employed to advantage in determining the necessary minimum section modulus which would give a predetermined maximum fibre stress in carline members, since the summated section moduli of all roof carlines can be considered as supporting or resisting the total roof bending moment or

$$\Sigma Z_v \times S_v = \frac{P_r \times N_r \times b}{8} \quad\text{.......... (13)}$$

$$\text{and } \Sigma Z_h \times S_h = K\left(\frac{P_r \times N_r \times b}{8}\right) \quad\text{.......... (14)}$$

and if it be further desired that Sh=Sv, or Sh=$Smax \div 2$; and $Smax$=24,000 lb. per sq. in., then

$$K \times \Sigma Z_v = \Sigma Z_h$$

and substituting for Pr its value in terms of unit weight of roof

$$\Sigma Z_v = \frac{W_r \times b^2\,L}{13{,}824{,}000} \quad\text{.......... (15)}$$

The total section modulus of carlines resisting vertical bending per 100 sq. ft. of roof area is

$$\frac{\Sigma Z_v}{100\text{ sq. ft.}} = \frac{W_r \times b}{960} \quad\text{.......... (16)}$$

Substituting for b its value of 102 in. and for Wr a value of 14.0 lb. per sq. ft. (16) then becomes

$$\frac{\Sigma Z_v}{100\text{ sq. ft.}} = 1.5\text{ in.}^3 \quad\text{.......... (17)}$$

$$\text{and } \frac{\Sigma Z_h}{100\text{ sq. ft.}} = K \times 1.5\text{ in.}^3 \quad\text{.......... (18)}$$

From equations (4) and (5) the value of the constant K was determined as approximately 13.5. Substituting this value

$$\frac{\Sigma Z_h}{100\text{ sq. ft.}} = 20.25\text{ in.}^3 \quad\text{.......... (18a)}$$

If the carlines be secured to the plates with gusset connections (18a) becomes

$$\frac{\Sigma Z_h}{100\text{ sq. ft.}} = 13.5\text{ in.}^3 \quad\text{.......... (18b)}$$

The total section modulus of roof carlines to resist vertical bending should be 1.5 in.^{3} about the horizontal axis and 20.25 in.^{3} about the vertical axis for each 100 sq. ft. of roof area.

END FRAME

Static Load Stresses.—The column load stresses in the end frame members due to the weight of end framing and sheathing are usually so small compared with the total stress due to end pressure of lading itself as to be safely omitted. The chief function of the end framing is to prevent distortion of the car body by end pressure or the bulging action of the

lading when shifting under sudden changes in the speed.

This pressure considered as acting horizontally and tending to bend the frame members outward, increases with the depth of load and at any height h the total lateral load is

$$E = \frac{\frac{1}{2}\, w\, h_1^2\, b \tan^2 (45 - \phi/2)^*}{1728}$$

where E = Total pressure.
ϕ = Angle of repose of commodity.
$\theta = \frac{1}{2}(90 - \phi)$
h_1 = Height of grain or coal in car in inches.
w = Weight of commodity per cu. ft.
b = Width of load or car in inches.

Under conditions of actual operation the height of the load at the ends of the car may approach the value of h (inside height of the car) and for maximum conditions h may be substituted for h. The total end pressure then becomes

$$E = \frac{w\, h^2\, b \tan^2 \theta}{3456} \qquad (19)$$

and the end frame members present the case of a beam, either fixed or supported at both ends, with a load varying uniformly from zero at one end to a maximum at the other. Considering the ends as supported, the maximum bending moment is

$$M_e = \frac{2\, E\, h}{9\sqrt{3}}$$

Substituting for E its value from equation (19),

$$M_e = \frac{w\, h^3\, b \tan^2 \theta}{1728 \times 9 \times \sqrt{3}}, \text{ or}$$

$$M_e = .000037\, w\, h^3\, b \tan^2 \theta \qquad (20)$$

Further if it be required that 75 per cent of this total endwise bending moment be resisted by the end reinforcement members and the remaining 25 per cent be taken up by the body corner posts, then

$$M_e \text{ reinforcement members} = .75\, M_{max} = .000028\, w\, h^3\, b \tan^2 \theta \qquad (21)$$

$$\text{and } M_e \text{ corner posts} = .25\, M_{max} = .000009\, w\, h^3\, b \tan^2 \theta \qquad (22)$$

Where the design of car framing is such that vertical members are connected to the under-frame and to top rails in such a manner as to be equivalent to the conditions of beams having ends fixed or rigidly connected, it is possible to use lighter sections for resisting the bulging action. Under these conditions the total maximum bending moment in the end frame members under static load is

$$M'_e = \frac{.0395\, w\, h^3\, b \tan^2 \theta}{3456} = .0000114\, w\, h^3\, b \tan^2 \theta \qquad (20a)$$

at a point $.423h$ above the floor. Another maximum will be found at the top and bottom connections, the value of which will be

$$M''_e = \frac{.0889\, w\, h^3\, b \tan^2 \theta}{3456} = .0000257\, w\, h^3\, b \tan^2 \theta \qquad (20b)$$

If the same division of the load between the end reinforcement members and the corner posts is used as before, the corresponding moments are

$$M'_e \text{ reinforcement members} = .75\, M'_e = .00000855\, w\, h^3\, b \tan^2 \theta \qquad (21a)$$

$$M''_e \text{ reinforcement members} = .75\, M''_e = .0000193\, w\, h^3\, b \tan^2 \theta \qquad (21b)$$

which occur at a point $.423h$ above the floor and at the top and bottom connections respectively. Similarly, the values for the corner posts are

$$M'_e \text{ corner posts} = .25\, M'_e = .00000285\, w\, h^3\, b \tan^2 \theta \qquad (22a)$$

$$M''_e \text{ corner posts} = .25\, M''_e = .0000064\, w\, h^3\, b \tan^2 \theta \qquad (22b)$$

Inertia Load Stresses.—Under the effect of sudden changes in speed the endwise pressure would tend to vary and the normal static angle of repose would be found greatly to exceed the angle of repose when the commodity is further influenced by inertia.

The writer has been unable to learn of any experiments or tests which have been made with a view towards locating the resultant angle of repose in such cases or towards determining the exact endwise pressure. It is believed, however, that a safe assumption would be to consider the endwise pressure as due to a volume of commodity back of the wall equal to the wedge of height h and angle at lower edge equal to $(90 - \theta)$ or approximately twice the wedge considered in static equilibrium. Then the expression for total endwise pressure due to inertia is

$$E_I = K\left(\frac{w\, h^2\, b \tan^2 \theta}{1728}\right) \qquad (23)$$

and the corresponding bending moment in end frame members due to inertia can be shown from formula (20)

$$M_{eI} = 2\, K\, M_e = .000074\, K\, w\, h^3\, b \tan^2 \theta$$

whereupon by substituting value of K from equation (4)

$$M_{eI} = .001\, w\, h^3\, b \tan^2 \theta \qquad (24)$$

With the end frame members sustaining bending moments equal to 75 per cent total maximum end bending moment the requisite section moduli of these sections becomes

$$\Sigma Z_{eI} = \frac{.75\, M_{eI}}{S}$$

Substituting the following numerical values: $w = 60$ lb.; $h = 72$ in.; $b = 102$ in.; $\theta = 30$ deg.,

$$\Sigma Z \text{ reinforcement members} = \frac{.00075 \times 60 \times 72^3 \times 102}{20{,}000 \times 3} = 28.6 \text{ in.}^3$$

at a height of 24 in. above the floor.

Based upon vertical end reinforcements fixed or rigidly connected at the ends, the required section modulus for uniform section is given as

$$\Sigma Z \text{ reinforcement members} = \frac{.75\, M''_{eI}}{S}$$

$$M''_{eI} = 2\, K\, M''_e = 2 \times 13.5 \times .0000257\, w\, h^3\, b \tan^2 \theta$$

$$M''_{eI} = .000694\, w\, h^3\, b \tan^2 \theta$$

Substituting the numerical values used in the previous case.

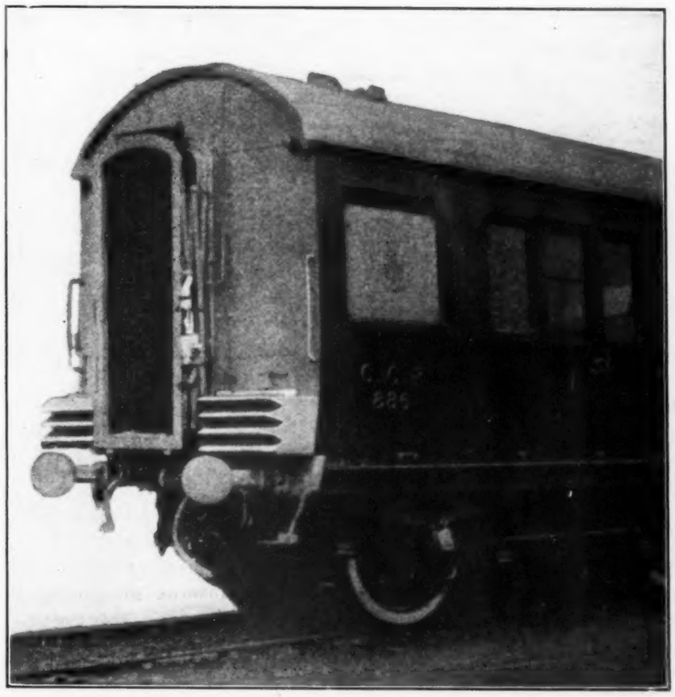
$$\Sigma Z \text{ reinforced members} = \frac{.75 \times .000694 \times 60 \times 72^3 \times 102}{20.000 \times 3} = 19.8 \text{ in.}^3$$

(*To be continued.*)

*From Rankine's formula for the pressure of earth against retaining walls.

INTERLOCKING FENDERS AND COLLISION BUFFERS

The problem of minimizing the effect of collisions and to provide, if not immunity from telescoping, at least something nearly approaching it, has exercised the minds of British railway engineers and experts for many years past; but the



The Interlocking Fenders as They Appear on the End of a Car

necessity for further safeguards has been emphasized by the more recent accidents, involving loss of life and destruction of property. With the introduction of rolling stock of a much heavier character, the danger has naturally been increased.

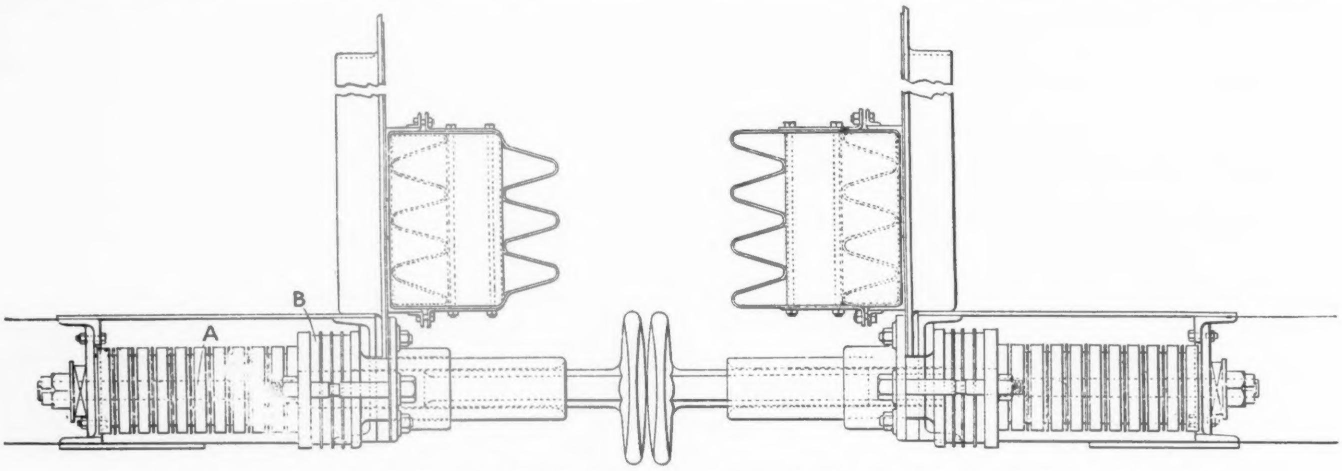
What is required is a buffing and interlocking arrangement whereby, when the shock of collision comes, the underframes of cars may be prevented from getting out of alinement. The patent anti-collision buffers and interlocking buffer fenders recently fitted to one of the London and Manchester express trains on the Great Central Railway by J. G. Robinson, chief mechanical engineer, appear to be an advance in the direction indicated so far as British practice is concerned.

It is not claimed that this invention will render telescoping of cars entirely a thing of the past, because the amount of weight in a collision varies in every instance, and in some cases the impact to be contended with is so great that it would be difficult to devise any means of withstanding it. The new collision buffers have a reserve stroke of 30 (long) tons, and will not collapse under a pressure less than 100 tons exerted at the ends of each car. Even then there are the collision fenders to offer further resistance and to materially help to absorb the force of the collision.

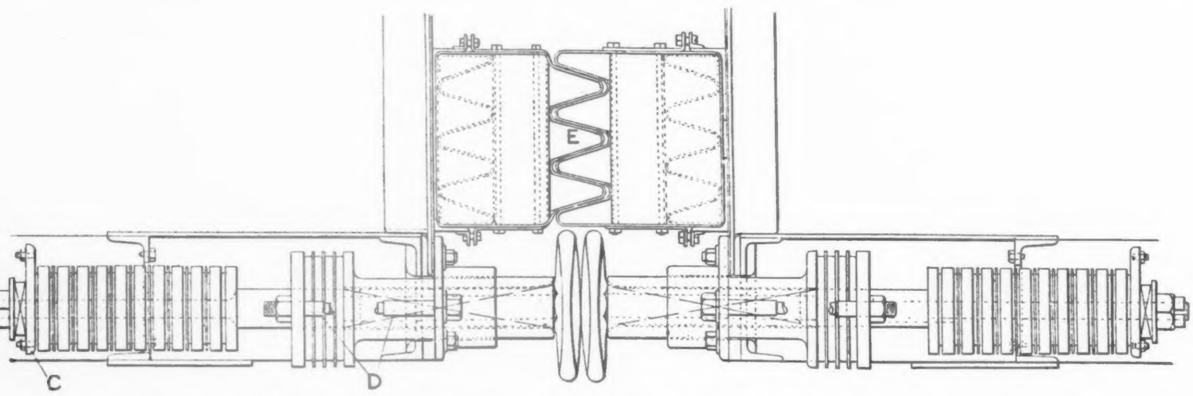
One of the difficulties to be overcome was the tendency for underframes to mount or override one another. In order to prevent this, as far as possible, the interlocking fender is introduced, with the result that the lateral alinement is preserved to a far greater extent than heretofore, the natural consequence being that a much heavier shock can be absorbed by the corrugated collision fenders.

While, however, the interlocking fenders work against the underframes mounting one another, it was felt advisable that further security should be provided by the strengthening of the cars themselves. The ends are steel plated or armored to prevent their being so suddenly telescoped in the event of collision as they would be if of the ordinary wooden type. Further, in the new armored coach, should the ends be forced in, it would be the upper portion that would give way first. The reinforcements are extended to the whole of the car, the roof and sides being strengthened by steel angles, braces and tie rods.

The collision fenders are placed at the ends as low down as possible over each buffer. These are rights and lefts, and are so arranged that they interlock when the buffers are driven home, broken or put out of action. The importance of this arrangement will be readily seen, for the very act of interlocking when the buffer is forced out of action prevents the underframe from rising or mounting. These fenders are formed of corrugated steel plates in three layers placed alternately and bolted together, being secured by angles on the endsill and the end of the body. They absorb a portion of the impact, thus preventing the underframes from telescoping the bodies. The Metropolitan Carriage, Wagon & Finance Company, Ltd., of Saltley, Birmingham, are the sole licensees.



Collision Fenders, Showing Ordinary Buffer Spring A and Reserve Stroke Buffer Spring B, in Normal Position



Collision Fenders, E, Interlocked; Resisting Bolts C of Ordinary Buffers and D of Reserve Stroke Buffers Broken

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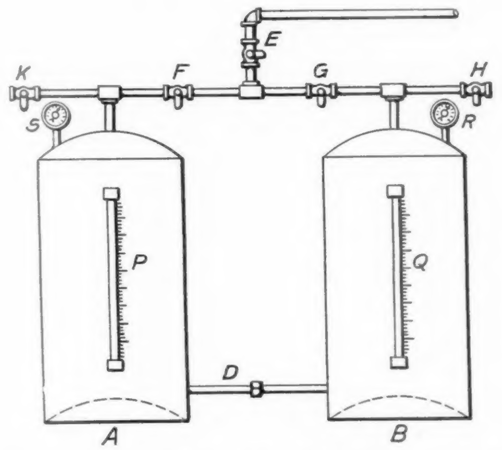
WEIGHT OF WROUGHT IRON.—The average weight of wrought iron is 480 lb. per cu. ft., or a bar 1 in. square section and 3 ft. long (36 cu. in.) weighs 10 lb. Therefore, to find the sectional area of a bar of uniform size throughout its length regardless of its shape, multiply the weight per foot by 3 and divide by ten (3/10). Example: An I-beam 4 ft. long weighs 72 lb. What is its sectional area in square inches? $72 \div 4 = 18$ lb. per foot. $18 \times 3/10 = 5.4$ sq. in. sectional area.—*Power.*

TESTING PNEUMATIC TOOLS

BY J. D. SMITH
Enginehouse Foreman, Philadelphia & Reading, South Bethlehem, Pa.

In a large shop where many air tools, such as chipping and riveting hammers, are constantly in service, it is a matter of economy that these tools be kept free from excessive leaks and worn parts. Hammers may be inspected once a week and given a thorough oiling, tested and found to strike an apparently hard blow, yet they may be leaking around their moving parts to such an extent that their efficiency is decreased considerably. In the absence of some means of testing and measuring the leakage, however, they are allowed to remain in service until they cannot be made to do the work. A hammer with a leaky valve or leaks around the piston or chisel bushing, will not do the work as quickly as a tight hammer with the results that the labor cost is greater than it should be and that the cost of compressing the air is increased to supply the leakage. These losses are proportional to the condition of the hammer and for a single tool may not amount to much, but where a great many such leaky tools are in service, the aggregate is considerable.



Equipment for Determining Air Consumption of Pneumatic Hammers

The condition of air hammers can be determined with ease and accuracy by means of a testing plant such as is outlined in Fig. 1. Two tanks *A* and *B* of ⅜-in. plate about 40 in. in diameter by 72 in. high, are connected by a 2-in pipe *D* at the bottom. These tanks are each filled half full of water when set up. They are fitted with water columns *P* and *Q*, so that the water level in each may be ascertained. Air from a pressure line enters through valve *E* and flows through valves *F* and *G* into the tanks.

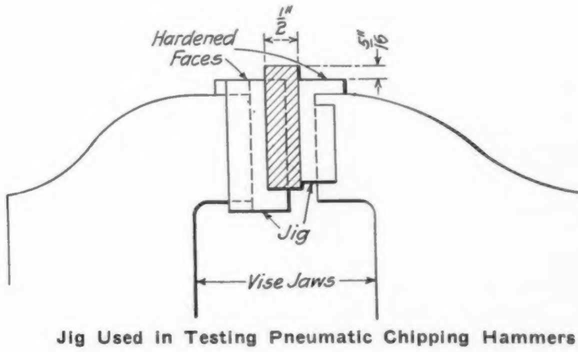
To determine the air consumption of a tool attach one end of a hose to cock *H* and the other end to the tool. Open valves *E, F* and *G*, and close valves *K* and *H* until the pressure in each tank is up to the desired test pressure. Then close all valves. At a given instant when the test is to begin, open valves *E* and *H*, allowing air to flow from tank *B* into the tool. Then open valve *F* enough to allow sufficient air to flow from the supply line into tank *A* to displace the water from *A* to *B* and force air from tank *B* into the tool at constant pressure. When the test is completed quickly close valves *H* and *F*. The water levels will not change as the air pressure will not allow the water to rise in *A*. By taking the time between the opening and closing of valve *H* and measuring the rise of the water in tank *B*, knowing the inside diameter of the tank, the volume of compressed air used per minute can be calculated. From this the equivalent cubic feet of free air per minute is obtained. When tank *B* is filled with water, tank *A* can be used, the hose being attached to cock *K* and the process reversed. The graduations on the tanks back of the water columns may be in fractions of a cubic foot of tank volume, thus facilitating the work by doing away with the measurement of the rise of water level with a foot rule. By this means a tool may be tested at any air pressure, limited only by the pressure on the air line, and its equivalent free air consumption calculated.

For example, a chipping hammer was tested for two minutes at 90 lb. gage pressure, and the rise of the water level was 10 in. Assuming that the inside diameter of the tank was 42 in., the equivalent cubic feet of free air consumed per minute was:

$$\frac{3.1416\times21^2\times10\times\ (90+14.7)}{1728\times2\times14.7}=28.5.$$

To test the hammer insert a blank set and allow it to operate against a block of wood, care being taken to hold the hammer up against the set in the same manner as when chipping or doing other work. Three or four of these tests should be made, of about one minute duration, from which the equivalent free air consumptions can be calculated and averaged. A standard equivalent free air consumption for each size and make of hammer can be set by thoroughly testing new hammers and taking the average of several tests.

To show the increased air consumption of a hammer in fair condition over a new hammer, a few used hammers apparently giving good service were selected for test at random from the supply at a large shop. Another practically new hammer of the same size and make was selected and tested along with the old hammers. At 80 lb. pressure it was found that the old hammers consumed on an average of 12 per cent more free air per minute than the new one. At 90 lb. pressure the increased air consumption of the old hammers averaged 15.6 per cent.



Jig Used in Testing Pneumatic Chipping Hammers

When it is desired to test the strength of a new hammer

in comparison with one of the same size, but of a different make, a chipping test may be made. A piece of ½-in. boiler plate about 6½ in. long is put into a special chuck (see Fig. 2), made to fit the jaws of a vise and the chuck then clamped in the vise. The plate should be placed so that 5-16 in. extends above the top faces of the chuck, which are hardened to form a guide and bearing for the chisel. The test consists in taking a 5-16 in. cut off of the boiler plate. A man experienced in operating a chipping hammer should be selected to make the test. The cut should be started flush with the top faces of the chuck and extended for about ⅛ in. From this point a distance of 6 in. is laid off as the length of the cut. At a given instant the cut is started and run the entire 6 in. without stopping. The chisel should be sharp and the cutting edge should be oiled as the cut advances. A good chipper can easily take this cut without stopping. The time required to make the cut is noted and the free air consumption calculated. Three of these tests at 90 lb. pressure, when carefully made, are sufficient to show the strength of a hammer.

A testing plant of this kind is also useful in determining the free air consumption of other air tools, such as air motors, the horsepower output of which can be measured at the same time with a Prony brake; boiler tube cleaners, and others. It is easy to operate, has no parts that will wear out quickly, and if the measurements are taken carefully, accurate results can be obtained. The apparatus can easily be made in any large shop.

PROCRASTINATION, THE THIEF OF TIME

BY F. A. WHITAKER

Procrastination has caused the downfall of many a good mechanical officer. If he had used good judgment and done the work on his engines when they required it and not tried to show how quickly he could turn an engine and furnish it to the transportation officers, the new laws governing the inspection of locomotives would never have been. The Government has only said what shall be done; and, by the way, the Government is only asking to have done what should have been done all the time. Consider any of the requirements of the new law, and no one who is a mechanic can say there is anything there that is unnecessary both from a maintenance standpoint and "safety first." The fixed standards arrived at by the Interstate Commerce Commission are not as high as some of the standards already in use on a good many railroads at the time the law went into effect, but like a good many standards they were subject to diversions and were carried out to suit the particular time and place. Under the new laws the mechanical officer is protected in doing the necessary work at the necessary time; no procrastinating goes if he wants to stay on the job and live peacefully.

The author believes that these laws are the best that have ever been promulgated for the mechanical officer, and if our mechanical men will only realize that they are already in effect and get down to business in regard to carrying out the instructions, the railway companies and themselves will be better off 12 months from now than they are at the present time. A lot of mechanical officers are under the impression that if they can get their engines by the Interstate Commerce Commission inspectors everything is all right; but the man who thinks this is either in the wrong place or deceiving himself. Any good roundhouse foreman knows the condition of his engines, and if he has the proper support from those above him should be able to keep his engines within the law's requirements. The author has found through personal contact with the inspectors that any foreman who shows any inclination to carry out the law receives every consideration from them, and besides it is the railroad company's business to inspect and repair all defects regardless of whether the inspectors find them or not. The foreman who only keeps his engines in shape when he is expecting the inspector is bound to get caught and after he does he is a marked man.

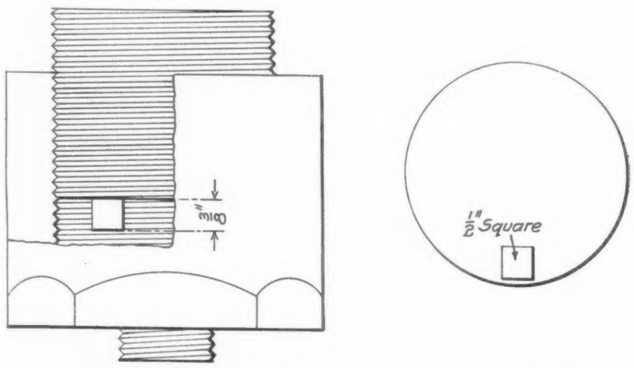
As regards the railway company's inspection, some of us are criticised because we are not careful enough; our inspectors are not as alert and observant as they might be. My personal experience has been that if we had more men to do the work and fewer inspectors we would be better off. It is not the lack of inspectors nor the closeness of the inspection; it is the lack of men, time and material to do the work that has been found by the inspectors. Not every foreman has the backbone to say that the work found by the inspectors shall be done before the engine leaves the terminal, and if we are going to inspect engines for defects and find them and then not repair them what is the good of inspecting? The only solution, it would seem, is that when necessary work is found and reported the foreman must have the work done, regardless of the time the engine is wanted, before it is allowed to leave. This, of course, will result in more talk and argument with yardmasters, train despatchers, etc.; but it should be noted that when the Interstate Commerce Commission inspectors serve Form 5, the work is then done, and it should be distinctly understood by all concerned that no engine should be continued in service with any defects regardless of how badly the engine is wanted. No man can build up an organization on procrastination and when you are tempted to let work go by today because you haven't time, remember that tomorrow you may have less.

A SIMPLE GREASE CUP PLUG

BY JOHN P. RISQUE

Mechanical Engineer, United Railways of Havana, Havana, Cuba

The drawing shows the standard grease cup and plug of the United Railways of Havana. There is nothing unusual about the cup, and the only novelty about the plug is the square lug which is cast on the bottom. The function of this plug is to imbed itself in the hard grease, where it acts



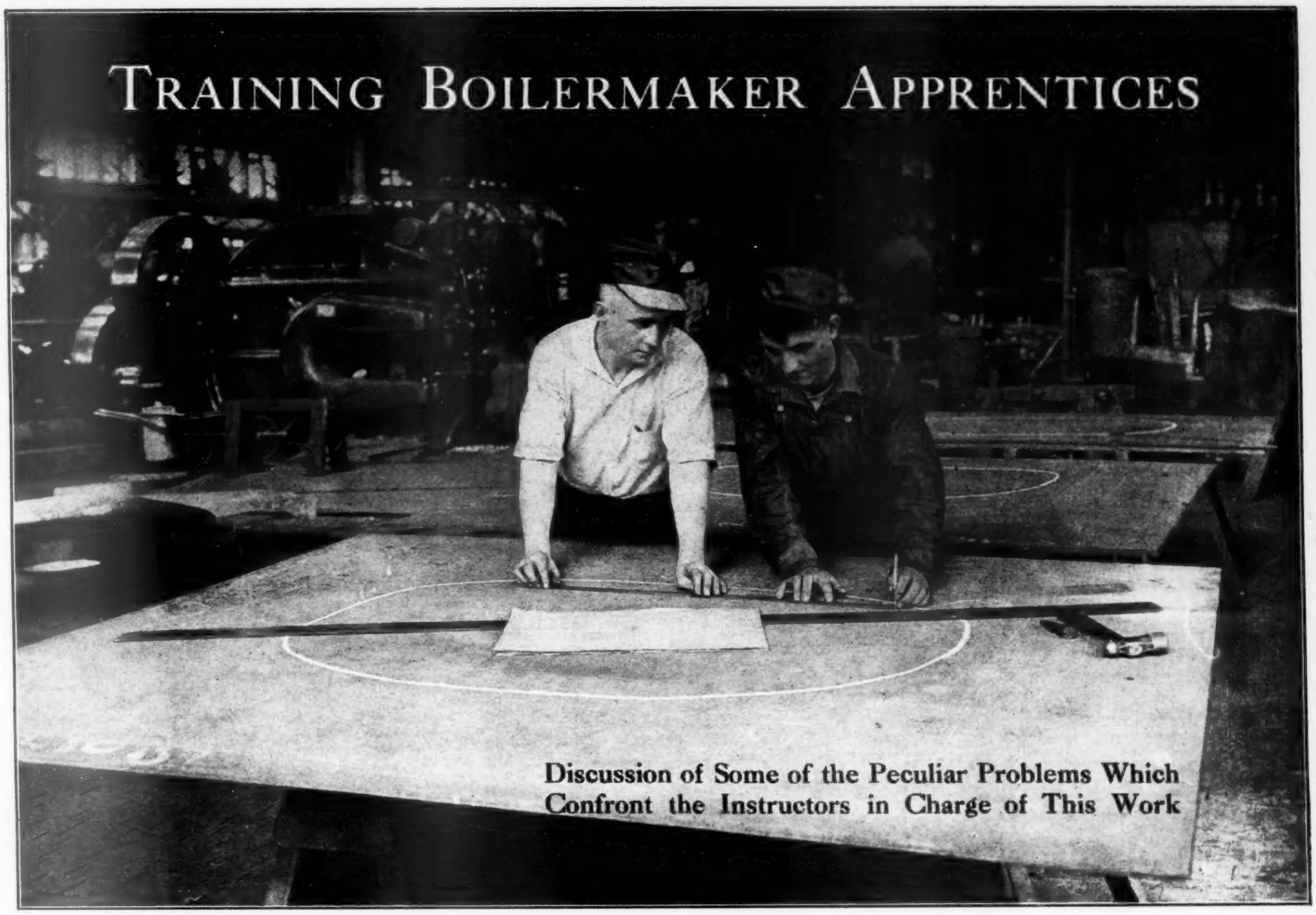
A Grease Cup Plug Designed to Lock in the Grease

as a lock, the grease keeping it from turning and consequently from unscrewing and loosing out of the cup. No lock nut is used with this plug. It simply screws into the grease, and stays there until somebody unscrews it.

More Rapid Steaming With Smaller Sizes of Coal.—With a given size of furnace and draft sufficient for equally perfect combustion, the smaller sizes of coal will become burned and will generate steam more rapidly than the larger sizes. The more finely divided the more promptly are the combustible elements of the fuel raised to the temperature of combustion and sooner brought in contact with the oxygen of the air supply, resulting in more rapid combustion and a quicker liberation of heat than from combustion of larger sizes of coal.—*Power.*

TRAINING BOILERMAKER APPRENTICES

Discussion of Some of the Peculiar Problems Which Confront the Instructors in Charge of This Work



Instructing Boilermaker Apprentice in Laying Out Work

DEVELOPING and training locomotive boilermaker apprentices is no easy task. This subject, with that of training freight car carpenter apprentices, took up most of the time at the annual meeting of the Santa Fe apprentice instructors which was held at Topeka, Kan., May 25-27. An account of the general features of this conference appeared in the *Railway Mechanical Engineer* of July, page 363.

George Austin, general boiler inspector of the Santa Fe, attended the meetings during the time this subject was being discussed, and gave the men splendid ideas as to the training of the boilermaker apprentices. He went through the book of rules for boiler inspection published by the Santa Fe, and pointed out those features which should be most carefully watched both in the shops and during inspection. Not only were the rules themselves discussed, but also the best means of imparting the information to the boy. Ability to *apply* the rules is what counts, not mere familiarity with the wording of the rule. Interest was added to this discussion by stereopticon views, and by samples of properly and improperly applied patches and flues. The Santa Fe now has four boilermaker apprentice instructors, these men having no other duties than to instruct and train the apprentice boys of the boiler shops.

Mr. Austin brought out a number of important points which he had found in his experience as general boiler inspector to be sources of considerable trouble. He explained the proper method of applying patch-bolt patches, copper ferrules in tube sheets, and believed that the boys should be given some instruction on the proper maintenance of boilers, such as might be learned in a roundhouse. He also pointed out that considerable is to be learned from the "scrap pile." Many defects caused by improper work will be seen there and will serve to caution the boys against doing their work improperly. He strongly advocated that the boys be given thorough instruction on inspection, suggesting various points which should be carefully watched.

The instructors also had an opportunity of asking questions from the representative of the mechanical engineer's office who handles the calculations for the factor of safety of boilers and the efficiency of boiler seams.

WHAT ASSISTANCE SHOULD BOILER SHOP INSTRUCTOR GIVE APPRENTICES?

F. C. Reinhardt, apprentice instructor in the boiler shop at Cleburne, Tex., presided. The boiler shop instructors agreed that the instructors should not only tell a boy how to do the work correctly, but should actually show him how to do it. First explain the job to be done; that is, what is to be accomplished, the purpose and the place used. Then show or demonstrate enough to give a correct idea both as to handling the tools and going ahead with the work. There is not much danger of showing too much, but the instructor should not try to do all the work for an apprentice. He should watch the work until sure that the boy can do it satisfactorily. Strive at all times to gain and keep the confidence of the boys. Study each individual and handle accordingly. There is a great deal of difference between boys even in the same shop. They cannot be handled alike. Some will need more demonstrating than others. It was also pointed out that the instructor should mix with the boys and be one of them. He should be prepared at all times to take hold and help the apprentices. This will result in their doing more and better work. It will take more time at first, but will save much

time later on. It was suggested that foremen in distributing work among the apprentices should notify the instructor when they put a boy on a new class of work, in order that the instructor may see that the boy is properly started.

HOW TO TEACH LAYING OUT

Arthur Moon, apprentice instructor in the boiler shop at Albuquerque, New Mex., presided. In teaching laying out, the first steps should be taken in the school room where drawings of the objects are made to scale, developed, cut out and assembled. The first laying out jobs in the shop should be closely supervised by the instructor. The apprentice should follow the laying out job to completion. Blue prints should be carefully studied and thoroughly understood before beginning the work upon the plate. The importance of properly squaring up a sheet was brought out. Apprentices should have experience on all of the laying out jobs done in the boiler shop. The apprentice should start with the light sheet metal work and later work on the heavier grades. After the boy demonstrates his ability he should be left to his own resources, but the work should be checked by the instructor and any errors pointed out and corrected. Work of this nature should be given to third and fourth year boys only. Whenever possible, apprentices should fit up the work they lay out. Special school room problems are now in preparation to go with this work.

APPRENTICES AND SPECIAL WORK

Charles Schmidt, apprentice instructor in the boiler shop at San Bernardino, Cal., acted as chairman. The apprentices should not be worked with handymen, but with journeymen, and should not be used as helpers merely to carry tools. Some of the boilermakers do not explain work to an apprentice, consequently the shop instructor should do so. It is as much the duty of the shop instructor to see that the apprentice is given the various classes of work as it is to assist him after the work is assigned. The management intends that the instructors shall be held personally responsible for this. The best method of giving a boy work done by a special man is, so far as possible, to have the boy placed with the man doing the work. It seems that at some points, especially the smaller places, the boys have not been getting much of this class of work. This may be due to the fact that there is only about enough to keep one man engaged, and if an apprentice is placed with the man, it will lower the man's efficiency, as two men's time will be charged, when it is only one man's job. In this connection, J. Purcell, assistant to the vice-president, said that he wished all of the boilermaker apprentices to be given some of this special work. It will be necessary for the apprentice instructor to watch for an opportunity and then use the boy. This is particularly true with staybolt testing, hydrostatic tests, etc.

Mr. Purcell's idea for training apprentices for inspecting staybolts was to have the apprentice go over the staybolts of a firebox while the engine is on the hospital track, and mark on the standard form each staybolt he thought to be fractured or broken; this, in addition to the regular report made out by the staybolt inspector. After the firebox is cut out or the marked bolts are removed, have the apprentice go over his report and notice if the staybolts he had marked are the ones fractured or broken. In this way he can learn to distinguish fractured and broken staybolts by sound.

WORK FOR TRANSFERRED APPRENTICES

J. H. Lewis, apprentice instructor in the boiler shop at Topeka, Kan., acted as chairman. Certain classes of work are not performed in the smaller shops, and other work is not done at the larger shops. To remedy this the instructors agreed that each boilermaker apprentice should be transferred sometime during his apprenticeship, preferably during his sixth or seventh six months' period, so that he may get the various classes of work offered in both the larger and smaller shops. Apprentices should be transferred from the smaller to the larger shops to get laying out, patch welding, flanging, flue sheets, door sheets, fitting up new work, etc., and any other work that is not done in the smaller shop. Apprentices should be transferred from the larger to the smaller shops to get roundhouse experience, running repairs, hot work, front ends, patch bolt patches, etc. Mr. Purcell said the instructors should see to it that the boys *did* get *all* the different kinds of work. In connection with this the following schedules of work were adopted:

FROM LARGER TO SMALLER SHOP OR ROUNDHOUSE

6 weeks grates and hot work.
6 weeks patch bolt patches and hand riveting.
6 weeks staybolts and plugging cracks.
4 weeks inspecting, hydrostatic tests and staybolt tests.
4 weeks front ends and ash pans.

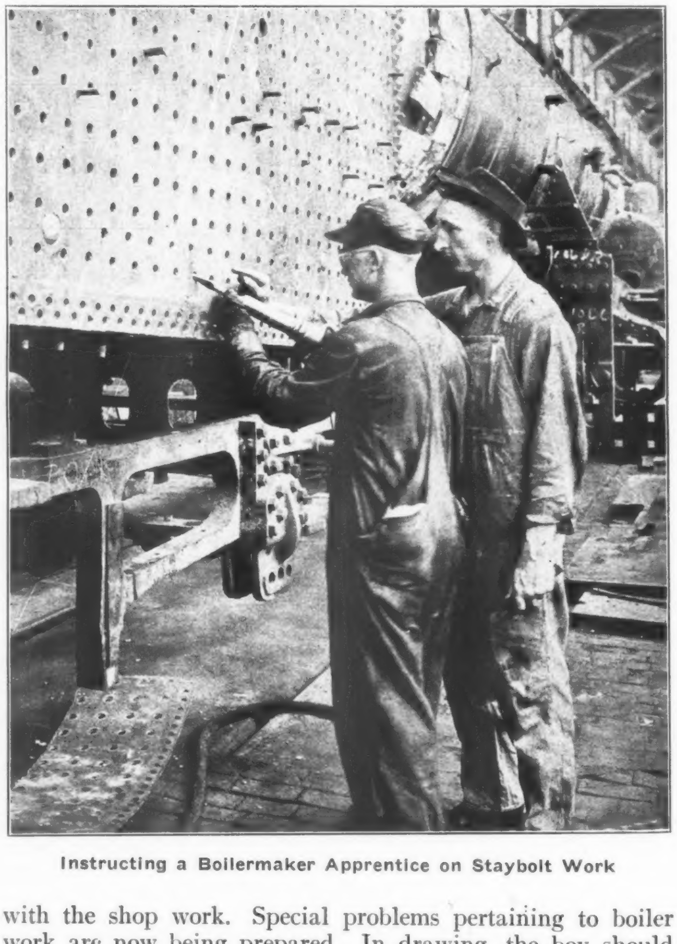
FROM SMALLER TO LARGER SHOPS

6 weeks flue and door sheets and welded patches.
6 weeks fitting up new work.
6 weeks laying out.
2 weeks flange fire.
4 weeks radial stays.
4 weeks driving staybolts and radial stays.
4 weeks gas welding.
4 weeks inspecting, testing, etc.
2 weeks welding and swedging flues.
2 weeks flues.

Also, if possible, keep him for a year, giving him the remainder of the time on general boiler work.

ADDITIONAL SCHOOL WORK

G. T. Peterson, apprentice instructor at Albuquerque, New Mex., acted as chairman. The school work should harmonize



Instructing a Boilermaker Apprentice on Staybolt Work

with the shop work. Special problems pertaining to boiler work are now being prepared. In drawing, the boy should complete the regular lessons for all trades through the geometrical construction problems; then the school room work should be designed to apply more directly to boiler work. Make all of the regular laying out drawings and extra draw-

ings from blue prints such as used in the shop. The laying out work done in the school room should conform to the work the boy is on in the shop. In school the parts are laid out to scale, cut out, and pasted together. This gives each boy an opportunity of seeing for the first time how the work will appear when rolled and assembled. While on general boiler work, the boy should systematically study the Locomotive Folio (a book of Santa Fe standards), learning what it contains pertaining to boilers and subjects closely related to boiler work. In general, his work in the school should conform to what he is doing in the shop and in addition he should be required to study the folio, boiler rules, learn to calculate strength of joints, seams, patches, etc. The boiler instructors were asked to visit the school rooms during class sessions in order that they may assist in special work for the boilermaker apprentices, as this will greatly assist in correlating the school work with the needs of the boys in the shop.

HANDLING A BIG ENGINE TERMINAL*

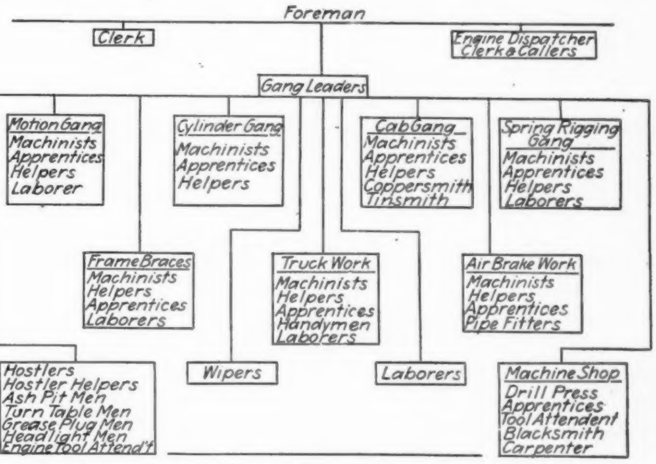
BY HARVEY DE WITT WOLCOMB

So much time and study has been given in the past few years to develop better engine handling facilities at the large terminals that it is almost impossible to suggest any new ideas on this subject. Where we do find any special system, it is usually on account of some necessary local requirement or is some "hobby" of an official, and so it is not fair to hold up any one of these systems as an example for the terminals in general to pattern after. Of course, the key-note of successful enginehouse management is "system," and in many of the up-to-date roundhouses the place will almost run itself without the foreman in charge being on the job. To one who has been raised in the old-time roundhouse, where the foreman has to be a sort of magician to produce the results that are required of him, it would seem that more credit should be given the man who can produce "big results from a small terminal" than to one who can produce "results from a big terminal." Such items as the type of engine used, the tonnage hauled, the length and the grades of the division, the nature of the water used, the class of workmen employed, and the distance from the general repair shop, govern the system that is best suited and from which the best results can be secured; therefore let us consider only such things as are applicable to all roundhouses.

An organization, to be effective, must have enough foremen or gang leaders to properly cover their assigned tasks without giving too much time to small details. In other words, the foremen and workmen should each have their place and should be trained to handle their respective parts in such a manner that it would not be necessary to go into any details covering the jobs they are to do. As an example of this system, the leader of the truck repairs will be notified that an engine requires a new pair of tank wheels, and it will be his duty to get the wheels required, place the engine on the pit where the work can be handled most conveniently, and look after all the many small details that may come up in connection with this work. If this line is followed out, it will be found that the perfect system for a roundhouse handling about 90 engines a day of 24 hours will not require any great number of foremen, but can be successfully managed with the work sub-divided under gang leaders. In fact, one good, live roundhouse foreman can get along better than to have several foremen where the assignment and distribution of responsibility is so divided that in the end no one man will take the entire responsibility but will put it up to the other fellow.

In the diagram which shows the plan of organization, it will be noted that only one foreman is shown for the entire roundhouse, and in turn the gang leaders, acting as sub-foremen, report to him direct. This line-up is intended for the medium-sized terminal, and in case it is desired to check this system against any of the large terminals, the diagram can be altered to suit these conditions by changing the title of roundhouse foreman to general roundhouse foreman, and the titles of gang leaders to assistant foremen, and still use the idea of gang leaders for all classes of work. There are many reasons for this system, chief of which is that each gang can have any special tools which might be used on their work and no time will be wasted in getting started on a rush job. Another valuable point is, that in case of any question about a job not being done properly the responsibility can quickly be placed just where it should be. Still another important point is that where the same gang is doing the same work every day they are more liable to discover some point in the equipment that can be improved so as to make their work easier, and also the study of efficiency has proved that one thing can be done better when specialized than doing several things at different times. It is a fact that the supply of "all-around" mechanics is not as plentiful as in years gone by, so it is necessary to make specialists to efficiently handle the several jobs. One other point that should be spoken of is that in an organization of this kind every man knows his place and just what is expected of him, so that if the system is well balanced the routine business will be handled without any hitch.

The weak points in equipment is a subject that has



Organization of Roundhouse Forces

not been given the proper attention in the past and today we are continually meeting the necessity for costly repairs in the roundhouse, that could have been avoided. In order to prevent future trouble of this kind the roundhouse force should be constantly on the watch to report and have corrected any faults in the construction of the locomotives. Under this same heading standardization of different parts might be brought up, for the roundhouse is the place where this is the greatest source of trouble. Adopt a good standard part that will suit all classes of engines and then maintain that standard. This means less material to be carried in stock, less cost to manufacture in quantities, and no time lost when required in a hurry. Very often it is cheaper to throw away a broken part and use a standard part than it is for the roundhouse force to waste time in patching up the broken piece. Work in a roundhouse is handled under so many handicaps that it is the most expensive and therefore should be confined as much as possible to simply renewing worn-out parts or patching broken parts when absolutely necessary. On the other hand, it is also very expensive to steal parts from one engine for another, so if standard parts are carried in stock, and can be used, the cost of running repairs will soon prove that the system is economical.

Substituting cast steel castings for brass castings and forgings will not only reduce the cost of maintenance but will

*Entered in the Engine Terminal Competition.

also give such better service that the parts will not require as much attention and repairs.

The real secret of successful roundhouse operation is the loyalty of the men, and cutting out any lost motion that might result in delays. At a point where even minutes wasted means a possible failure, it does not pay to have one gang rush after their part of the work and get it done in record time and then have some other gang waste so much time that the engine gets behind on its schedule. As a rule, this happens in nearly every place, for an engine will be delayed on the ashpit for over an hour, and then when it gets in the house the spring rigging gang will be asked to perform some record work so as to get it out again on time. So that the first and one of the most important parts of the organization is the ashpit, which should be under the supervision of a head hostler. This head hostler should be the best that can be secured, and should receive high wages, for on him depends the length of time that it takes to get an engine in the house after it reaches the terminal. The best man on this job is none too good, and he should receive all encouragement in his work. We all know that when a terminal gets "tied up" during a heavy storm, the greatest trouble is generally at the ashpit; and the time that can be saved at this point will give more time in the house for inspection and repairs.

Each class of engine should have a printed list of special points that are to be looked after or checked up at the boiler washing period. This list should be made to include the regular boiler washing records, and when the engine is completed the list should be signed by the leader in charge and the names of the men working on the job with him. The main idea of this list is to take care of any weakness in a part that is liable to cause a failure, but it can also include the inspection of any part that is under test. Some roads have a regular printed list of jobs that must be looked after at this time, but the better plan is to have a list made out separately to cover each specific class of engine, for on some engines there are points to be checked up that the other engines do not have.

The roundhouse foreman should have time to study his surroundings so as to change his organization if conditions demand it. He must watch his different gangs to see that one gang is not working short handed or that another gang has too many men. He must also keep in touch with the enginemen and find out anything they want done, for the successful foreman is not the one who slights his work, but who tries to do all in his power to keep the engines in the best condition.

Each gang should be equipped with a large tool box on wheels, that can be easily moved from one engine to another. This box should contain all the tools necessary to handle their special line of duties. Jacks should be distributed around the house at several points so that it is not necessary to walk any great distance to get one. If each gang is given the tools for their work, it will be found that a large, expensive tool room is unnecessary. If there is a tool room, it should be under the care of the head machine hand in the machine shop, and he can maintain the tool repairs in his leisure moments.

As the winter is the most severe on equipment, all means possible should be taken to make the roundhouse as comfortable as possible so that the work can be given prompt and effective attention. Sometimes it is impossible to get good mechanics to work in the roundhouse on account of the steam and gas, and if this can be prevented it will benefit all workmen. The best system of lighting is the headlight system; that is, have a strong electric headlight placed at the front and back of every pit and the light will be given in such a way that there will be no reflection on the work.

The old idea that a man is a good workman just because he appears to be a hustler is wrong, for we find many men who work hard but do their work under such conditions as are usually found in the poor roundhouse, who do not, as a rule, turn out very much or very good work; and if their shop conditions can be bettered, they are bound in turn to become better workmen. Overcoming failures and handling a great number of engines includes "hustle" to some extent, but on the other hand it requires the elimination of all unnecessary moves and wasted time, so that the best way to increase the efficiency of a terminal is to study every operation and find some way to better the conditions and reduce the handicaps.

HEAT TREATMENT OF STEEL*

BY GEORGE HUTTON

What is heat treatment? A method of changing the structure of any steel forging from its normal state after the forging operation to a more efficient article by increasing the tensile strength. The process is as follows: First, annealing all forgings to relieve strains set up by hammering and unequal heating during the process of forging; second, heating to a certain temperature and quenching in a cooling medium to attain density of structure and tensile strength; and, third, reheating to a lower temperature to attain elasticity and allowing to cool in a dry place or in the furnace. A correct knowledge of the carbon content of the steel, which is essential, the proper temperatures for the different operations together with a properly calibrated pyrometer, a cooling tank, running water of the right temperature, or a suitable quenching oil, and facilities for the quick handling or transferring of forgings from furnace to cooling tank, constitute the necessary requirements for the heat treatment of forgings generally used in locomotive work.

To describe technically the various changes the steel undergoes by heating and cooling is only confusing to the average shop man, and is not absolutely necessary to success in heat treating. In all well regulated railroad shops the foreman who has supervision over the heat treating receives instructions from the proper authorities regarding the temperatures for quenching and draw-back, the quenching medium to use and the physical test which the forgings are expected to stand after treatment; therefore, his principal duty in heat treatment is strictly to follow out these instructions. However, let it be borne in mind that there is something more essential than just heating and cooling steel. One should know the nature of the material he is working, also the results obtained after certain operations, viz.: if the forgings are improved; if the structure of treated steel when fractured shows evidence of overheating or underheating; if it has been hammered when too cold or too hot; if the test piece when pulled shows the right texture; if a test piece shows an ideal or undesirable fracture, etc. All of these are practical points with which the man who works in steel or iron should be familiar.

For heat treating, a muffle or semi-muffle furnace is required, preferably with a door at each end, and a perfectly flat bottom. If main and side rods or axles are to be treated a car-bottom furnace with a removable bottom mounted on wheels is required. The hot forgings are pulled out of the furnace on this truck, thus facilitating the handling of long forgings without bending. For forgings four feet long or less the removable bottom is not necessary as all short forgings can be readily removed from the furnace without distortion. When forgings are placed in the furnace care should be taken to stack them so that one will not come in contact with another and so that they will not sag when hot. The forgings should be charged when the furnace is cold to insure proper placing. If an oil furnace is used the combustion chamber should be large enough to distribute the flame evenly over the entire heating space above without coming directly in contact with the forgings. A pyrometer must be

*Second prize article in the competition which closed May 1, 1916.

used to ascertain the temperatures and care should be taken to see that the forgings themselves are at the correct temperatures. For instance, the pyrometer may show 1,500 deg. F. while the forgings may not have reached that temperature. A radiation pyrometer is excellent for this work as it eliminates guess work in this respect, the temperature of the forgings only being indicated, regardless of the temperature of the furnace.

There should be provided a sufficiently large cooling tank, preferably round and sunk to within one foot of the floor level, filled with water which should be at a temperature of at least 80 deg. to 90 deg. F. when the forgings are quenched. The tank should be fitted with supply pipes and overflow so that the temperature can be maintained regardless of the number of pieces being treated. If a soluble quenching oil is used the tank should be equipped with a pump and storage reservoir so that the oil will circulate at the above temperature without waste. There should also be provided a crane or trolley working from the furnace to the cooling tank with quick hoisting and lowering facilities. The same furnace may be used for the draw-back heats only at a much lower temperature.

Take, for example, forgings made from open-hearth steel or open-hearth vanadium steel having a carbon content of .35 per cent to not over .50 per cent. If the forgings are to be treated before machining, which is the case with most locomotive forgings, excepting crank pins or other short, round work, they may be rough turned before heat treating. The forgings should first have been annealed at a temperature suitable to the carbon content, from 1,550 deg. F. to 1,650 deg. F., and allowed to cool. They are placed in the furnace and the temperature raised slowly to 1,500 or 1,550 deg. F., *conforming always to the carbon,* and held at that temperature from one-half hour to one hour, depending on the weight or thickness of the pieces. The temperature should steadily rise to the desired point and never be allowed to drop back during the operation.

Each piece should be removed from the furnace and quenched as quickly as possible. In all cases of heat treatment, steel should be quenched at a rising temperature or one which has been maintained constant. The forging should not be kept submerged until it reaches the temperature of the cooling medium, but should be removed while it is still hot enough for oil or water to sizzle on it. This can easily be determined by practice and no rule can be laid down to govern the length of time required in the quenching bath, especially for irregular shaped forgings.

After the quenching operation the furnace is allowed to cool down about 200 deg. F., the forgings again being placed in it the same as before and the temperature raised from 1,250 deg. F. to 1,310 deg. F., depending on the requirements which they must meet. The furnace may be cooled off with forgings in it or they can be taken out and stacked in a dry place to cool.

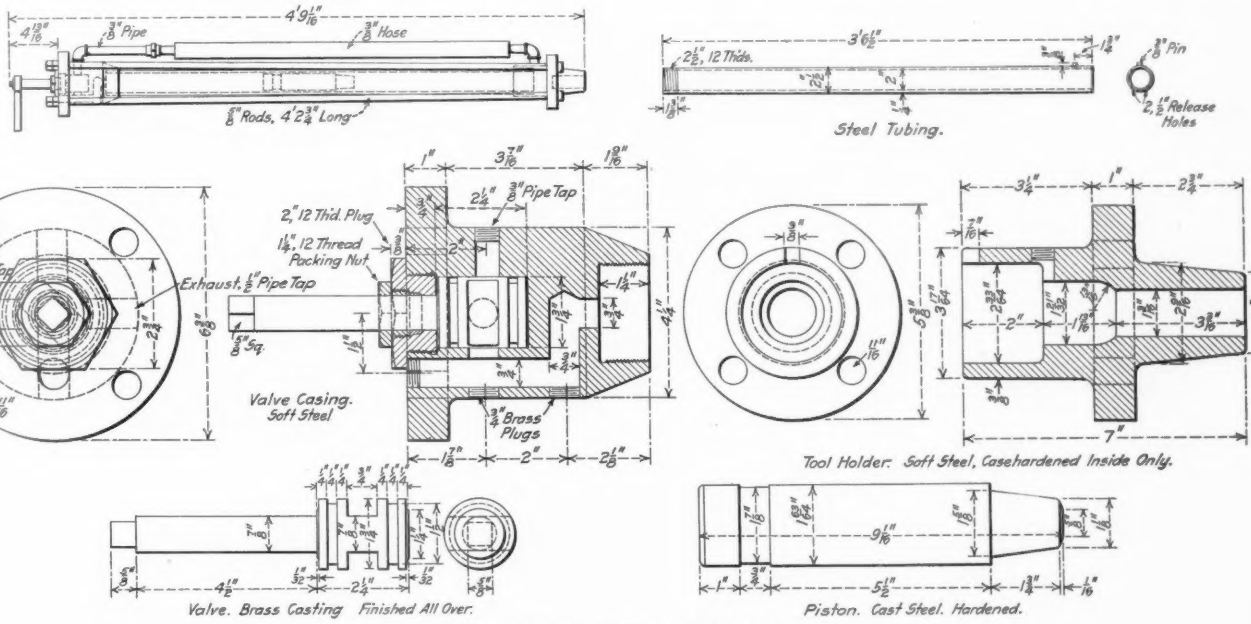
By these operations the tensile strength of the forgings has been increased from 80,000 lb. per sq. in. to 120,000 lb. per sq. in., and can be increased still more, although too high a tensile strength is not always desirable. The relative hardness and toughness of steel forgings can be controlled by the temperature of the furnace according to the requirements of the article being treated.

RIVET CUTTER FOR FREIGHT CAR REPAIRS

BY H. M. BROWN
Shop Superintendent, Chesapeake & Ohio, Huntington, W. Va.

In repairing steel freight cars it has been the practice at this point to use a sledge and cutter for the removal of rivets. The rivet cutting required on a car in the shop for general repairs ordinarily takes from four to six days, with a gang of four men. In order to reduce the time the cars are detained in the shop, the pneumatic hammer shown in the drawing has been developed for doing this work. By its use the time consumed in cutting rivets under the above conditions has been reduced to about 14 hours.

The machine is built up of two heads machined from old tire steel, and a barrel of Shelby steel tubing. A piston, 1 63/64 in. in diameter, works in the barrel and it has been found unnecessary to finish the latter, as the tubing is received sufficiently smooth to answer the purpose satisfactorily. The heads and the barrel are held together by means of four ⅝-in. rods passing through the flanges of the heads.



Rivet Buster Used in Repairing Steel Cars

The upper head is fitted with a valve working in a cylindrical chamber, by means of which connection can be made alternately between the inlet port and the upper end of the barrel, and between the inlet port and the lower end of the barrel, the same operation placing the end of the barrel not in communication with the inlet port directly in con-

nection with an exhaust port leading to the atmosphere. The hammer is operated by turning the valve about on its own axis, a handle being provided on the projecting end of the stem for this purpose. Two relief holes are drilled through the barrel 7½ in. back from the lower end.

When the rough service to which these hammers are subjected is considered, they have required very little maintenance since they have been in service. They have also resulted in a saving in cutters as well as in the elimination of the danger of personal injury, which always exists where the sledge and chisel are used.

LOCOMOTIVE PIPING AND JACKETS

BY M. J. CAIRNS

From the manner in which some roads apply piping and jackets to locomotives, it is quite evident that but little consideration is being given to obtaining an arrangement which embodies ease of application and removal and neatness of appearance. This thought has very likely occurred to quite a few roundhouse foremen when a staybolt needed replacement. Rather than remove a section of the jacket covered with numerous pipes running apparently in the line of least resistance, they proceed to punch a hole through the jacket and lagging, for which they cannot be greatly censured. The description, dealing with the arrangement for a Pacific type locomotive, is offered in an effort to bring more thought to bear upon this subject.

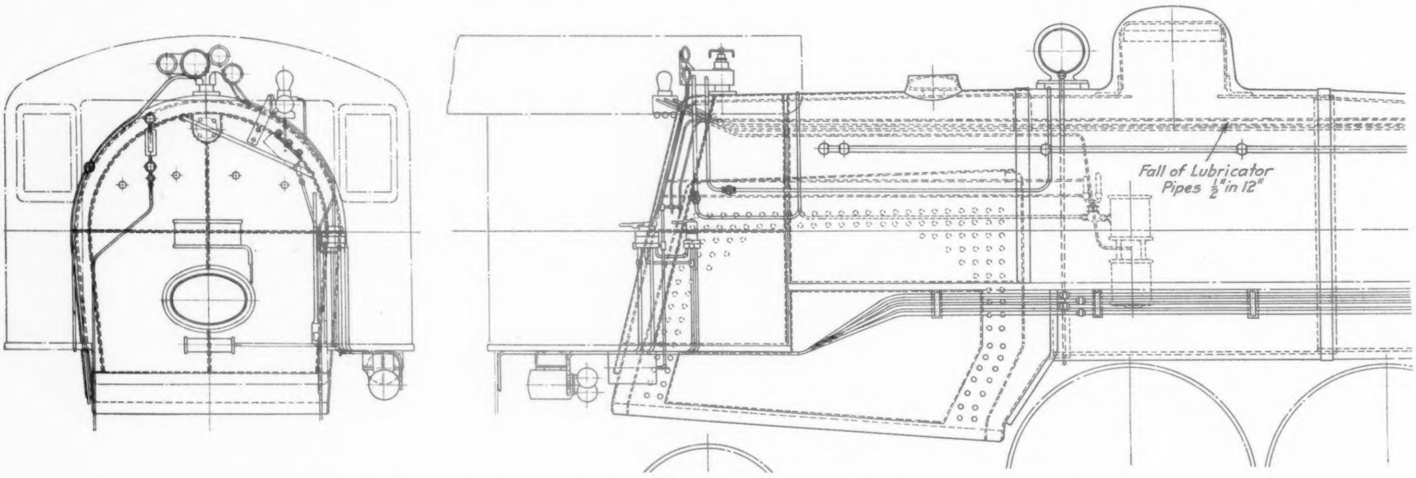
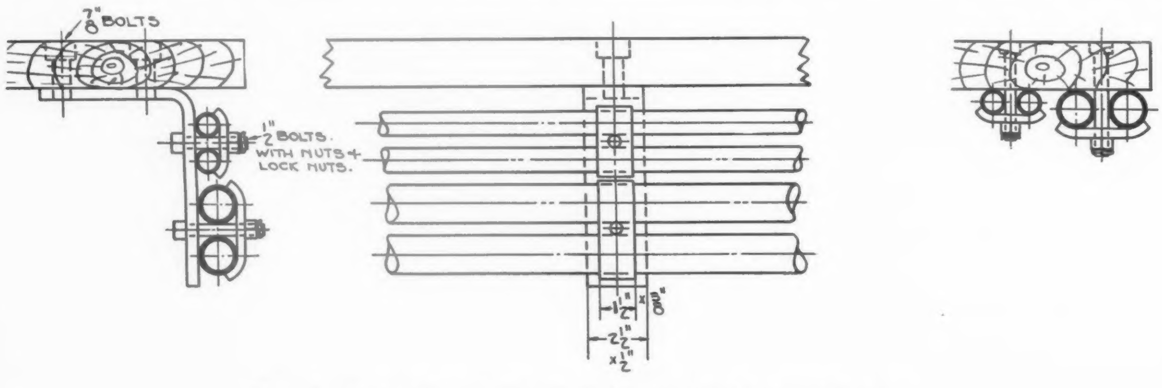


Fig. 1—General Arrangement of Locomotive Piping Which Will Expedite Removal and Repairs

PIPING

The various pipes running ahead under the running board, such as the blower, steam heat, signal and train line, main reservoir and brake cylinder pipes, may be suspended in a row from the outer edge of the running board, as shown in the arrangement drawing, Fig 1, and in Fig. 2. If it is not deemed advisable to use this arrangement on account of the obstruction offered by the air cooler pipes or an exceptionally large reservoir, the pipes may be laid flush with the running board as shown in Fig. 3. The pipes under the cab should be arranged as shown in Fig. 3, which is an improvement over the present method of running them in a row over the side sheets, which will require their removal when work is to be done in that section. Unions should be applied just ahead of the throat sheet and above the cab floor on those pipes which extend upward, thus supplying a long felt want where stripping is necessary when working on staybolts.

In the cab the gage pipes running from the automatic brake valve and main reservoir pipe, the bell ringer and sander pipes, also the excess pressure pipe leading to the pump governor, can follow the corner band. The blower, the steam heat line, the gage cock and the water glass drains can do likewise at least over the bottom jacket section. This will clear the backhead, reducing the amount of stripping to be done to a minimum when replacing broken staybolts or cleaning tell-tale holes. The various lubricator pipes with the sander, bell ringer, and excess pressure pipes may enter under the jacket at the corner band as shown in Fig. 1, continuing forward to their respective positions with a fall of about ½ in. to the foot. These pipes had best emerge from the jacket at a seam rather than through a hole punched in the center of the jacket.



Figs. 2 and 3—Arrangement of Piping Under the Running Board

The turbine drain can enter under the jacket at the seam shown in Fig. 6, continuing under the jacket to the bottom center line of the boiler, where it can emerge for a short distance. This arrangement will give good protection against

freezing. The injector steam pipes should clear the jacket as much as consistent, taking care, however, that they are so braced that vibration will be eliminated. With non-lifting injectors, the delivery line can usually be arranged to clear the staybolt area by placing it on a line parallel with the front of the mud ring. The back corner of the mud ring may be cleared considerably by moving the distributing valve and equalizing reservoir back closer to the cab plate. Considerable time can be saved by properly placing unions, and the number of joints can be greatly reduced by the use of angle and globe valves with union outlets and elbows and tees with unions. Pet cocks should be applied at the lowest point in the pipe line, for proper drainage.

All pipes should be securely clamped, using nuts and lock nuts, eliminating vibration with its subsequent leakage and chafing. The use of graphite and oil is recommended for making the pipe joints. Copper pipes give the best results under the jacket, experiments with wrought iron pipes show-

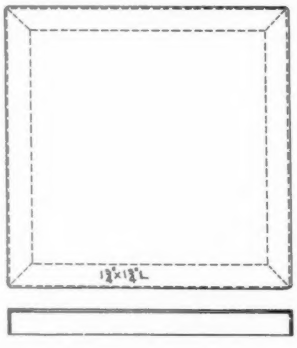


Fig. 4—Angle Iron Type of Construction for Holding the Lagging Over the Staybolt Area

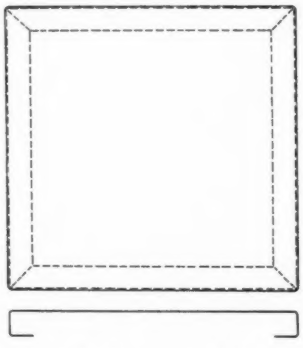


Fig. 5—Suggested Arrangement for Holding Scraps of Block Lagging; This May Be Removed in a Unit

ing that frequent renewals are necessary when they are so placed. Double strength pipes should, of course, be used for steam and air, thereby overcoming the breaking of threads experienced with single strength pipes due to vibration. Chafed pipes are being reclaimed to quite an extent by welding.

As an experiment, a large trunk line recently piped an engine using the foregoing arrangement at a cost of $170,

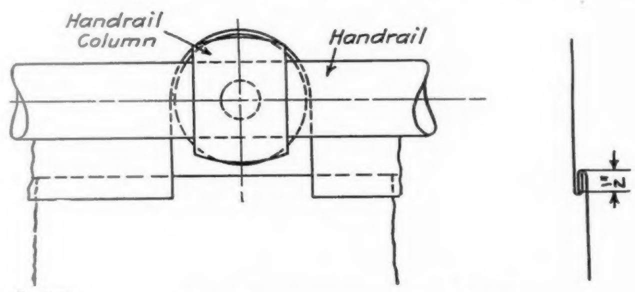


Fig. 6—Longitudinal Jacket Seam

including labor and material, in which some few small pipes were used from the material removed. The cost of replacing the old pipes just as they were removed was estimated at $70, making an additional cost for the engine of $100. This extra charge would soon be recovered if staybolt breakages were numerous, but the application of this arrangement to old power passing through the shop would, of course, require some consideration before the present arrangements were changed. However, for new engines or engines requiring many new pipes this plan can easily be followed.

JACKET AND LAGGING

The sectional type of jacket should by all means be used over the firebox, the number of sections being such as to facilitate staybolt replacement. The usual form of construction is the angle iron type shown in Fig. 4, which is applied over block lagging in the common staybolt area and over bulk lagging plastered around flexible staybolts. Fig. 5 is a suggestion for a jacket section in which bulk lagging made from scraps of block lagging may be applied, the lagging being held in place by means of chicken wire or thin metal strips acting as a binder. This could be placed over common staybolts and the whole section removed as a unit, saving the time now used in re-applying the jacket and lagging separately. Fig. 6 shows a longitudinal seam suitable for use on the barrel of a boiler. This allows the removal of the jacket without disturbing the handrail columns, which is especially desirable when applying barrel patches. The use of rivets is done away with, the sheets being lapped ½ in. and hammered together. The top sheet laps over the bottom sheet, thereby shedding water.

THE IMPORTANCE OF THE ROUNDHOUSE FOREMAN

BY G. C. CHRISTY
General Foreman, Illinois Central, McComb, Miss.

There cannot be too much said for the roundhouse foreman; a "live one" is the busiest man in the mechanical department. He has to be thoroughly posted on the enginemen's and firemen's contracts, has to be in position to answer any question right off the reel, and even talk with the men's wives on some occasions, trying to explain to them that they cannot get a pass for themselves within the next few minutes. He also has to be very much of a diplomat, to explain to the different enginemen why such work that was reported wasn't done, and why work was done that wasn't reported.

He has to be a good judge of human nature, that he may select the class of men that will make good and be an advantage to his organization; because if he hasn't a first-class organization, he cannot get results. "Results" in the roundhouse means more than one might think, without going a little further than the outbound track of the roundhouse. It means to have all engines thoroughly inspected for all defects, and then see that all defects are corrected in the proper manner within a limited amount of time, that the engine may be kept in road service instead of standing over the drop pit. Any foreman can discharge an employee, but it takes a good foreman to get results from one.

So it is with keeping engines in the service and also in good condition. Any foreman could run a roundhouse if he was permitted to shop the engines whenever he thought they were getting in bad condition; but it takes a man who will look ahead, to keep his power in good condition and at the same time keep it in service. If he has his engines thoroughly inspected, then sees that the work is done, he will be in such condition that none of the Government inspectors can come around about the time the engine is ready to leave the station, and order it out of service. Above all, this will reduce engine failures to the minimum, which are the worst trouble the master mechanic has to answer for.

The subject of engine failures attracts everybody's attention on the railroad from the general manager to the box packer who failed to pack the box that caused the failure. Even the commercial agent, who may be a thousand miles from the roundhouse foreman, is out doing his best, soliciting what the railroad depends upon—revenue. He gets the business and advertises the train to maintain such schedule that will deliver his customer's goods at a certain destination at some specified time. The train may maintain the schedule over several divisions until it arrives on some division with a weak organization in the roundhouse; the engine will get out late, causing terminal overtime, which is money, then get out on the road, fail for steam on account of tubes being

stopped up, or run hot, due to the application of new bearings and no lubricant, or some other cause. This will not only delay the train, but delay everything on the railroad.

The customer will go to the commercial agent and notify him that he doesn't want any more of his railroad's service. Then every officer, from the general manager on down the line, general superintendent, superintendent and master mechanic, will have to know the cause of the failure. A big file of correspondence will eventually arrive at the roundhouse foreman's office, for him to tell the entire railroad why they cannot run trains on schedule time. After the foreman has studied awhile, he will try to answer this correspondence in such manner as not to reflect on his organization, or his ability to handle a roundhouse. The best way to answer such delays is not to have them; by having good organization, which requires co-operation. To get this, the foreman must be absolutely fair and square with all his men and those with whom he comes in contact.

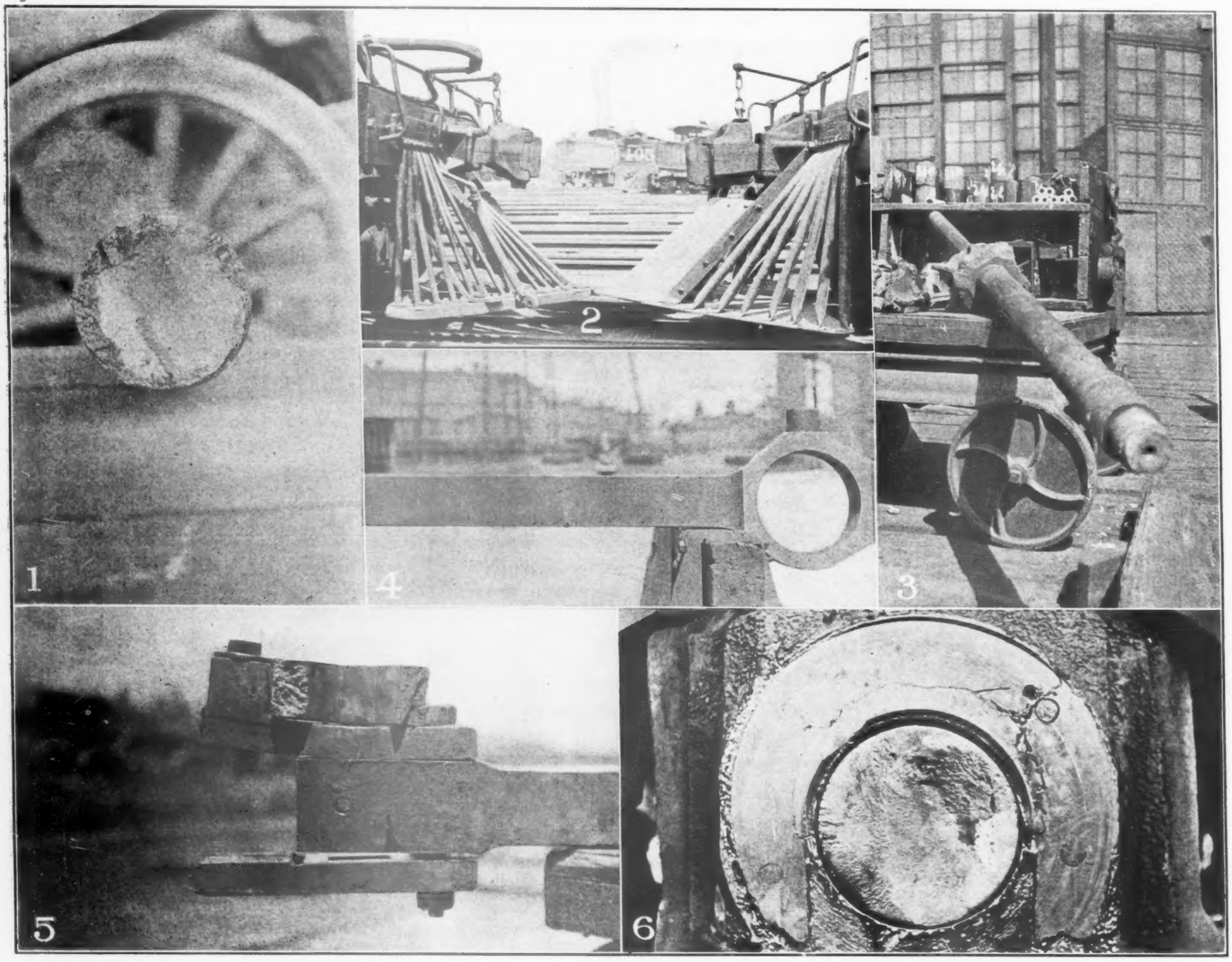
COMPOSITION OF COAL ASH.—Coal ash contains silica, alumina, iron pyrites and other mineral matter, depending upon the chemical composition and physical condition. These cause the ash to fuse more or less easily. The temperature at which firebrick will melt is sometimes influenced by the composition of the ash. For instance, a certain ash might melt at 2,600 deg. F. and a certain firebrick at 2,800 deg. F., but together in a furnace both might melt at 2,500 deg. F.—*Power.*

THE CAMERA IN A RAILROAD SHOP

BY C. L. DICKERT
Assistant Master Mechanic, Central of Georgia, Macon, Ga.

It is often necessary to make sketches and blue prints showing defective material, weak parts, broken parts, and a great many other things around a shop. It is very difficult in a good many cases to show up on a drawing the exact conditions and in some cases a lot of time is consumed in making drawings. We have overcome a lot of these troubles by the use of a camera. A photograph is taken of broken and defective parts, which shows up in detail the exact conditions in such a way that it cannot be disputed.

The camera is not expensive and does not require any skill to handle it. We do our own developing and printing.



Some Examples of the Use of the Camera in the Central of Georgia Shops at Macon

The accompanying photographs show some of the work done with the camera. Nos. 1 and 6 show broken driving axles; No. 2 shows a comparison between two locomotive pilots, one made with round iron ribs, the other with ribs made from scrap tubes; No. 3 shows a broken piston; No. 4 a cracked side rod, and No. 5 a broken front end main rod strap. Each film is numbered and dated, a book record is kept and the negatives filed for future reference.

STEAM TURBINES.—Highly economical steam turbines must necessarily be operated condensing, but there are many cases where high steam economy is not most important, and the non-condensing turbine often finds favor.—*Power.*

ELECTRIC FURNACES FOR TEMPERING TOOLS

The output and efficiency of any shop, whether railroad or industrial, is dependent on the capabilities of the workmen and the service obtained from the tools they use. The first is a matter of the experience of the workman and may or may not be in the hands of his employer to regulate. In the second case, however, it is not impossible nor difficult to provide proper tools with which the work is to be done. The tools must be properly formed and heat-treated. Tests have shown that a variation of 50 deg. in the heat-treatment of high speed steel makes a difference of from 30 to 70 per cent in the life of a tool according to its size.

This degree of refinement can be best obtained in electric furnaces provided with suitable pyrometers for the accurate determination of temperatures. Where these furnaces have been used they have been found especially successful. The equipment shown in the accompanying illustration is in use in the Burnside shops of the Illinois Central, where all taps, dies, reamers, shear blades and, in fact, all tools except lathe and planer tools, are treated by the electric furnace.

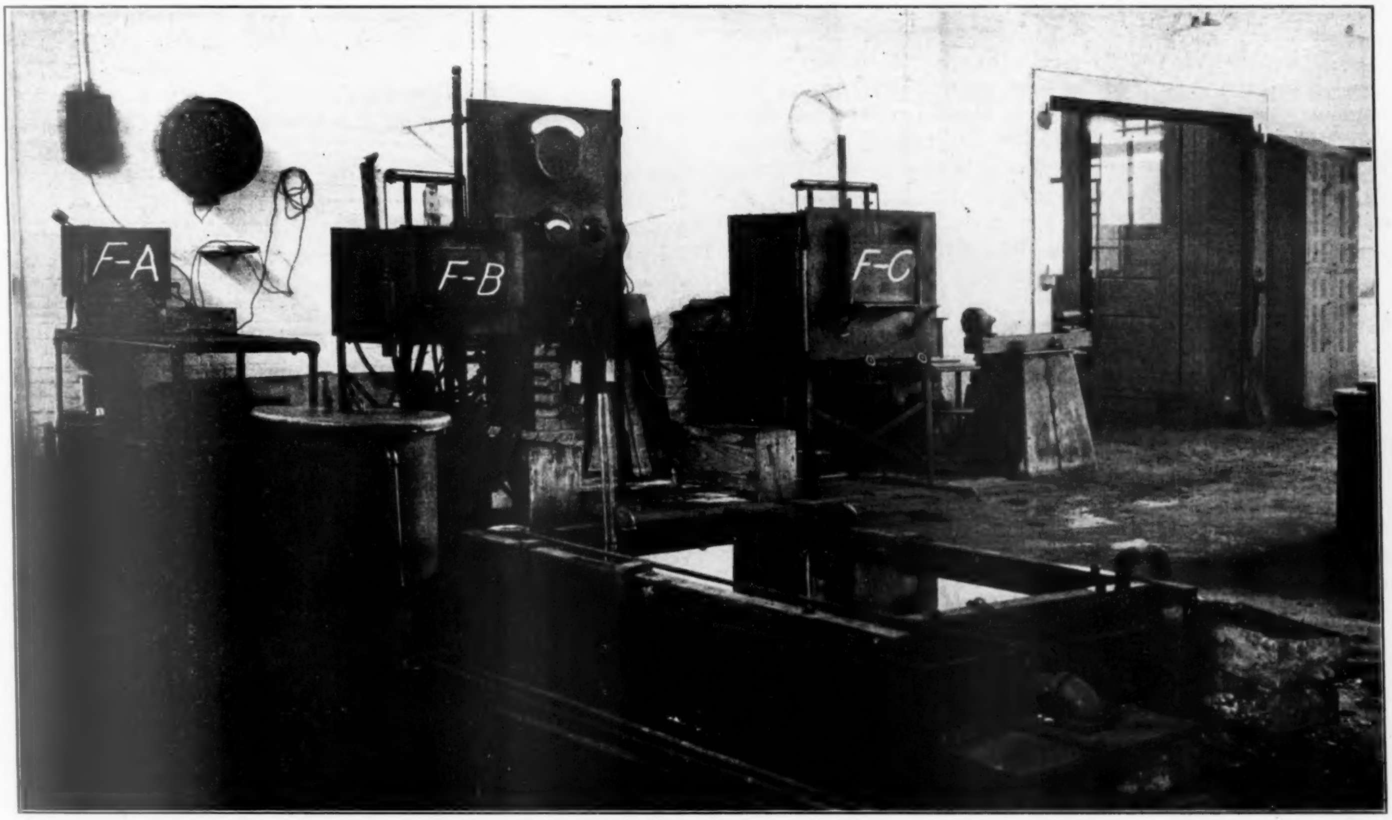
The equipment consists of types F-C, F-B and F-A electric furnaces made by the Hoskins Manufacturing Company, Detroit, Mich. The type F-C furnace is of the carbon resisting type with which temperatures between 1,000 deg. and 2,500 deg. F. can be obtained. It is used almost exclusively for treating high speed steel. The type F-B furnace is provided with heating units made of a special alloy of nickel-chromium wire of large cross section. This furnace is used where temperatures up to 1,800 deg. F. are desired, and is employed in treating tools of carbon steel. The type F-A furnace is used for tempering the carbon steel tools and, although temperatures of 1,800 deg. F. can be obtained in it, it is seldom heated to above 800 deg. F. for the service in which it is used.

The heating element which is employed in this furnace is made of Chromel wire wound on an alundum core.

The acknowledged advantages of this equipment by the road on which it is used are, the accurate control of temperatures, the number of tools that may be treated at one time, the less liability of imperfect tools due to oxidization, and the ease of operation with increased capacity. In regard to the latter item, it is said that with the installation referred to above, two tool dressers and their helpers have been eliminated. It must not be assumed, however, that with all the refinements in the construction of the furnaces and the accuracy in the control of the temperatures, the work of treating the tools can be done by inexperienced men. It is practically impossible to lay down a hard and fast rule for the heat-treating of the various grades of steel. The size of the tool and the work for which it is intended will determine its treatment, all of which requires the service of an experienced man. With the electric furnace he is able to get more uniformly perfect results and can handle a much greater amount of work with less labor.

Experience on the Illinois Central has shown that the best results with taps, dies and other tools made from 1.10 per cent carbon steel are obtained by heating them to between 1,350 and 1,600 deg., according to their size. The 0.9 per cent carbon steel which is used for mandrels, beading tools, etc., is heated to between 1,400 and 1,625 deg. W. C. Scofield, the foreman blacksmith who has charge of the work done in these furnaces, states that in hardening the tools he finds it more satisfactory to dip them on a declining temperature. That is, he heats them slightly above the desired temperature, then allows them to cool back again before dipping them. In dipping the spiral reamers they are rotated slowly in a direction opposite to that of the spiral. This, it is claimed, will prevent warping. The long taps and reamers are packed in charcoal in an iron tube, brought up to a red heat in an oil furnace and soaked at the proper temperature in the electric furnace.

It takes from 1 to 1½ hours to bring the furnaces up to working temperature, which might be considered a disadvan-



Installation of Electric Furnaces at the Burnside Shops of the Illinois Central

tage were it not for the fact that the gradually rising heat can be utilized in drawing the temper on some of the tools that were hardened the previous day, as is done on the road whose installation is described above. The temperatures at which the type F-B furnace is used range between 1,350 and 1,625 deg. F., according to the size of the tool being treated and the grade of the steel. Not being used to its full capacity the heating elements are not overtaxed and it has been found necessary to renew them only about once a year. This furnace is also used to preheat the high speed steel tools before they are placed in the high temperature of the type F-C furnace, this practice having been found necessary. In handling this grade of steel it is also necessary not to permit soaking heats; that is, as soon as the steel has been brought up to the required temperature it should be removed from the furnace. It is also necessary to allow a certain amount of air to enter the furnace while treating the steel, as it has been found that a reducing atmosphere will produce soft spots on the tools.

The type F-C furnace, which uses the carbon plates as heating elements, is used to more nearly its heat capacity, and it has been found that the carbon resistor and the carbon plates have a life of about 150 hours, while the bottom plates and electrodes have a life of about 500 hours. If the furnaces are allowed to overheat, the maintenance, of course, will be greater and the linings of the furnace will deteriorate. It is necessary that the pyrometer be accurately maintained and it should be checked once every two weeks, either by a standard pyrometer or by the use of melting metal cones having a known melting point. Alternating current at 440 volts and 60 cycles is used in the type F-B and F-C furnaces, while 220 volt direct current is used in the type F-A furnace.

GETTING RESULTS IN AN ENGINEHOUSE*

BY THOMAS F. RYAN
Roundhouse Foreman, Atchison, Topeka & Santa Fe, La Junta, Col.

It is almost impossible to lay down a plan of organization that will apply to all enginehouses alike. So many different conditions apply that each case must in the end be studied separately. The class of power, the class of service, the general characteristics of the employees, the size of the terminal and whether it is at a main shop or at an outlying point, all enter into the question.

However, the fundamental principle underlying all successful management is thorough organization. In this age a man not gifted with talent for organization in greater or less degree has no business at the head of any plant or department.

In all matters pertaining to shopmen and methods the roundhouse foreman should report to the general foreman, and in things relative to enginemen the roundhouse foreman should report to the master mechanic or to his office, as the general foreman of a busy shop has no time to devote to enginemen.

I would divide the work into several sections: Inspection, repairing and keeping accurate record of the work done. On arrival at the roundhouse tracks every engine should receive a thorough inspection. This means to test out the air equipment, test the boiler appliances, note the steam leaks, try the shoes and wedges and make needed adjustments, key the rods and test the engine for blows in the valves and cylinders, and report the defects found. The engine should then pass to the coaling station, sandhouse and cinder pit, and these should be all on one track. This track should lead direct to the turntable and should also be equipped with a water crane; 20 min. wasted on each engine going from one track to another at the end of a 50-engine day means 1,000 min. total delay.

Having reached the roundhouse we are now ready to begin repair work, and this need not be discussed farther than to say that the inspection should be made by competent practical men and the work they find should be done, as well as all necessary work reported by the enginemen. It should be done *right* and it should be done *now*. In the event that time and circumstances will not permit of certain repairs being made on the date of inspection, the report should be held and arrangements made to complete the work on the following trip. The old adage of saving the pennies and letting the dollars look out for themselves is no truer than that to do the little jobs on an engine will prevent the big ones.

With proper traffic conditions prevailing and with proper handling of power by train despatchers to keep engines arriving singly rather than in groups, repairs should be complete and the engine ready for service within eight hours on an average. As repairs are completed the outgoing inspection should begin and every item should be looked over and each appliance tested out to prove that it is in working order. This may sound like a large contract, but in practically every roundhouse there are a sufficient number of men to perform these duties, and here is where the ability of the roundhouse foreman as an organizer is shown most plainly.

I do not feel that it is appropriate to dwell on the matter of improving shop methods and tools and eliminating the lost motion in making repairs and in educating men to be efficient. Pages could be written on this subject, but I wish only to mention one device that is not used in all enginehouses. This is a portable tool box, mounted on an ordinary warehouse truck and containing sufficient wrenches, sledges and other tools to keep men from going a long way to the tool room every little while with all the incident temptations to visit a little. This will also eliminate tool cupboards from the roundhouse. When a mechanic is done with one engine he wheels his box over to the next.

In the office every item should be carefully attended to and record kept of the man doing the work. The easiest way to do this is to typewrite the reports for each engine and put them up on a wall board *at the engine* where they will be convenient for the gang foremen, mechanics and hostlers to check while the engine is in the house. When the work is done and the reports bear the signature of each man who did the work on the engine opposite the line on the report covering that operation, the report should be taken to the roundhouse office and filed. Every report on any given engine is thus available at any time. This also serves to locate responsibility for poor work, and further serves to convince enginemen that they are sometimes in error when they say a part that failed has been reported by them several times.

To get results from an enginehouse requires the co-operation of the transportation department. Trainmasters are anxious to keep their engine assignment down, and one of the surest ways of accomplishing this is to arrange for the long lay-over of the engines at the home terminal, and give the roundhouse men a chance to make repairs when they should be made and without overtime. I know the trainmaster does not figure the mechanical payroll, but the money all comes from a common treasury in the end. Yardmasters can help by advising roundhouse foremen in the morning what power they want for 24 or even 12 hours, and when they want it. It is easy for a roundhouse foreman to ascertain what traffic is coming, but what he would like to know is when it is going, and how much there is of it. Many an engine lies at a terminal amply long to do all necessary work if a number of engines had not arrived in a bunch at five o'clock in the evening, or if the roundhouse foreman knew they were going to be on hand 15 hours, before 8 hours of the 15 were gone.

*Entered in the Engine Terminal Competition.

MANUFACTURING STANDARD BRAKE LEVERS

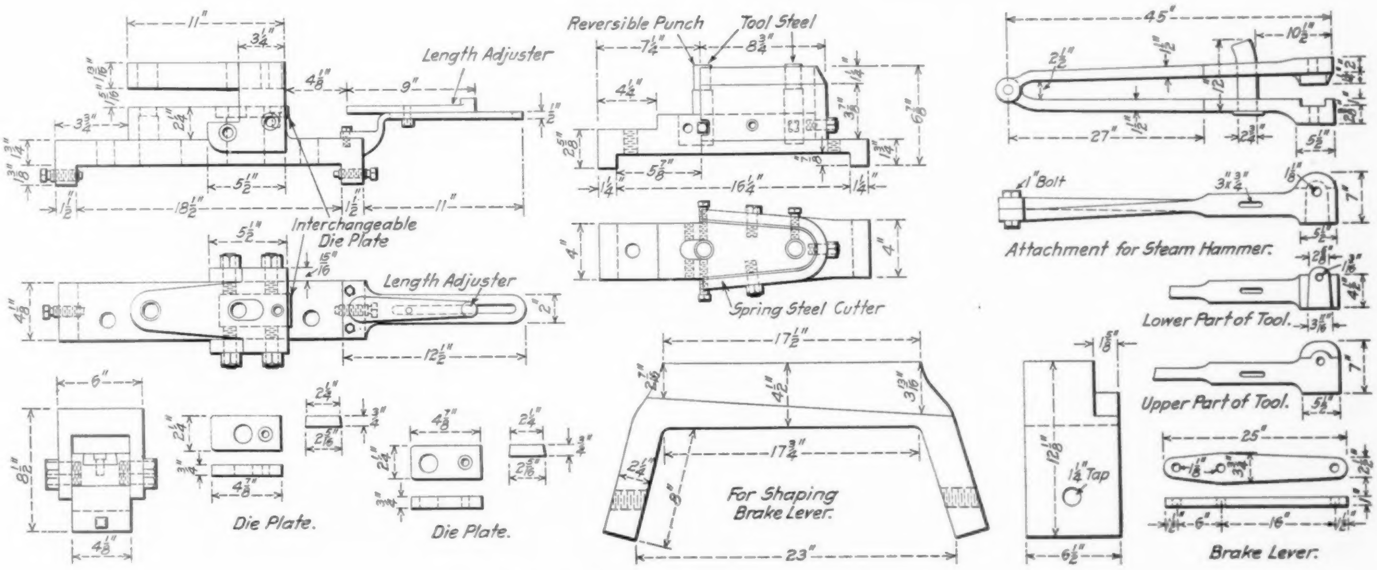
BY W. P. HOBSON
Master Mechanic, Chesapeake & Ohio, Covington, Ky.

A set of tools for the manufacture of brake levers for freight cars has been developed at this point by J. Mulcahy, blacksmith foreman, by the use of which the labor cost of the levers has been reduced about one-half. Previous to the design of these tools the brake levers were made under the steam hammer.

By referring to the drawing it will be seen that there are two sets of tools; the first for use with the steam hammer in forming and punching the long end of the lever, the other for finishing the short end and punching the remaining two holes. The latter set is used on a punching and shearing machine. The stock is first heated at one end and placed in the tool shown at *A*, which is attached to the anvil of the steam hammer. Three blows are used to shape the long end of the lever, after which it is placed in the tool shown at *B*, where the end is trimmed and the hole punched. The die in the lower jaw of this tool conforms to the taper of the brake beam, the end being trimmed by the cutter on the upper jaw. The trimming is done with one blow of the hammer, a punch then being inserted in the upper jaw and driven through the material by a second blow, thus completing the long end of the lever.

The center hole and the hole in the short end are punched and the end of the beam trimmed in the tools shown at *C* and *D*. Tool *C* is bolted to the bottom face of a punch and shear, while tool *D* is attached to the movable head of the machine. The brake lever is inserted between the stationary die and a guide plate over which works the movable die. The hole through the latter for the middle punch is oblong, thus permitting the use of two standard lengths between the holes in the short end of the lever. The lower die is fitted with an interchangeable die plate dovetailed and secured by a ½-in. cap bolt with a flush head. This tool is fitted with an adjustable stop, by which is determined the distance between the center hole and the hole in the long end of the lever. The movable die is fitted with two steel punches and a spring steel cutter for trimming the end of the lever. The middle punch is reversible to provide for the two standard lengths of the short end of the lever.

After the levers are finished at the long end, the short ends are heated and placed in tool *C* with the long end against the adjustable stop. With one stroke of the machine the remaining two holes are punched and the end of the lever trimmed to the finished dimensions.

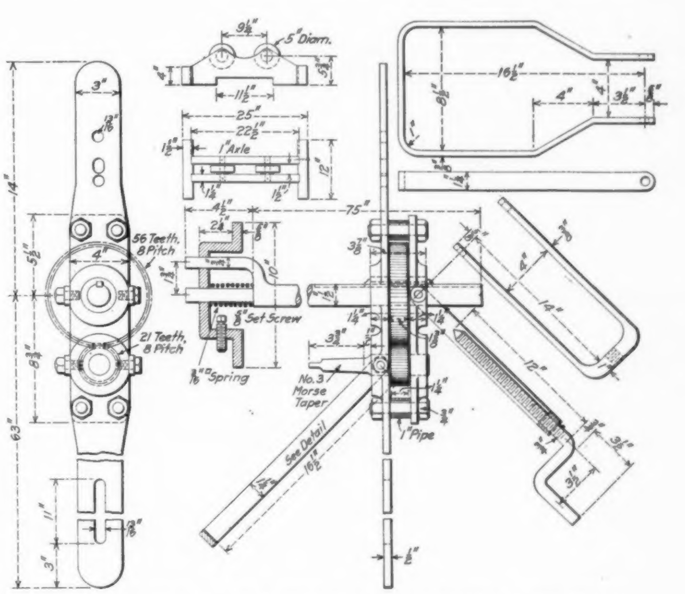


Tools for Shaping and Punching Brake Levers

GRINDING DRY PIPE JOINTS

BY H. C. GILLESPIE
Master Mechanic, Chesapeake & Ohio, Peru, Ind.

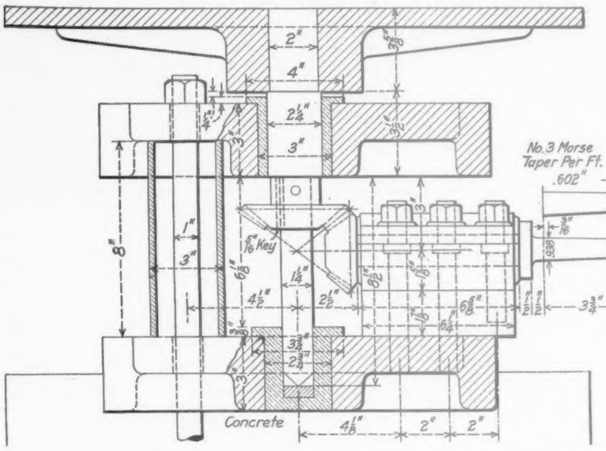
Drawings are shown herewith of two tools designed in the Peru, Ind., shops of the Chesapeake & Ohio for the economical and rapid handling of dry pipes and tee heads. This class of work, as a general thing, does not receive the attention it deserves, and as the result the methods used in repairing these parts are crude, in most cases the work being done by hand. A machine for grinding the dry pipe in the tee head is shown in Fig. 1. It was constructed out of two center plates and the bevel gears from an old jack. The tee head is fastened to the face plate and an air motor is attached to the Morse taper shank to drive the face place. The dry pipe is hung over the tee head by a chain block and enough



A Power Jack for Grinding Dry Pipes in the Tube Sheets

weight is allowed to rest on the tee head to grind the joint.

The arrangement for grinding the dry pipe into the tube sheet is shown in detail in Fig. 2. It works in a very satisfactory manner if care is taken to adjust the rollers to the



Machine for Grinding the Dry Pipe in the Tee Head

proper height at the back end of the pipe, and the job can be completed in the time it takes to grind it in by hand. The machine is very easily set up and can be handled by two men.

SOME POINTS IN ENGINEHOUSE MANAGEMENT*

BY C. E. KELLY

The first consideration in enginehouse management is the highest degree of efficiency at a minimum cost, and in order that this may be obtained there must be a man at the head of this work who is broadminded, fair and firm, and one who is farseeing.

Tracks for engines waiting ready to go out should be open at both ends so that engines can be placed on them or taken out without having to move other engines.

Stand pipes for taking water should be so located that water can be taken from several different tracks.

A roundhouse should be well heated in the winter. Much time is lost day after day by men standing by a stove to get warm.

In the handling of roundhouse forces I find that the method of making special jobs of the work gives good results; in some cases where there is enough work of any one class to assign a particular man to that job, he will sooner or later learn to equip himself with the material and tools that he will need for his class of work, and by continued practice he becomes very expert. However, this does not apply to all classes of work, for to specialize all the work does not meet with the approval of all the workmen. Many of them are better satisfied to work on different classes of work, as a change of work from time to time keeps it from becoming monotonous. For running repair work it is advisable to make a specialty of the valve work, the cab work and the air-brake work, and where heavy class repairs are made in the roundhouse special men may be assigned to this; also to the work of inspection. Where the inspector has no authority in regard to having the work done, but simply reports it and leaves it to the workman's judgment, he has to take someone's word for the actual performance of the work. The inspector should be held responsible for the manner in which the work is done.

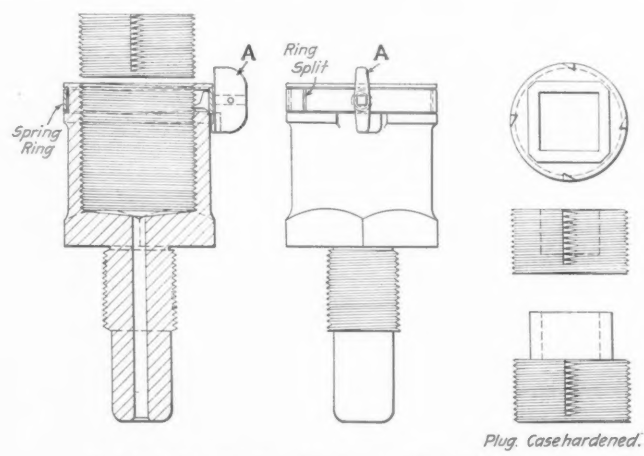
What methods may be applied to the enginehouse organizations in general to prevent engine failures? From a mechanical point of view there is no method by which all engine failures can be prevented. However, the number of engine failures may be greatly reduced in various ways. For instance, hot journals on tanks, trailers and engine trucks having a babbitt metal bearing in the crown of the brass, if examined at regular intervals by removing the brass so that all of it may be seen, will prevent many engine failures from hot journals due to the metal wearing out of the brass next to the hub, where it would not be detected in ordinary oiling or packing. Keep a record and have the brasses removed at least once every two weeks, and these hot box failures will decrease.

Make every man respect the necessity of doing the work in a correct and workman-like manner. The great secret of success in handling a roundhouse, large or small, lies in perfecting a system that will automatically assist in carrying on the business.

*Entered in the Engine Terminal Competition.

RATCHET GREASE CUP

A locomotive side rod grease cup has been developed and the patent applied for by C. E. Stocker, Mill Valley, Cal. The purpose of this special design of cup is to keep the grease plug from working loose while in service without the use of the troublesome jam nut. This is done by means of a ratchet. The pawl of the ratchet is mounted in a spring ring on the outside of the cup. The point of the pawl passes through the side of the cup and bears directly on the root of the thread of the grease plug. This plug has four V-notches



Ratchet Grease Cup for Locomotive Side Rods

made in the thread and slightly deeper than the root of the thread, as shown in the drawing. The point of the pawl engaging in these notches prevents the plug from working loose but does not hinder the screwing in of the plug. When it is desired to remove the plug the pawl is lifted from the V-notch by slightly turning the button *A* which rides on the wedge-shaped lug on the body of the grease cup. This cup has been tried on one of the large western roads and has proved successful.

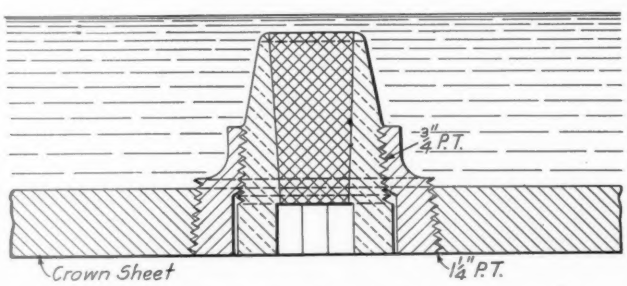
CRANES, HOISTS AND TROLLEYS.—The general provision of traveling cranes, jib cranes, hoists and trolleys in modern shops has made a great change in the manner of handling work and the attitude of mechanics to big jobs. When a casting weighing many tons had to be machined in the old-time shop it was a herculean job to transport it from one machine to another and fix it in position. So general has the power traveling crane become in the past few years that it is a commonplace sight to see machine parts weighing many tons being transported through shops and placed on machines with no fuss and requiring the help of only one or two men besides the crane operator.—*A. S. M. E. Journal.*

New Devices

FUSIBLE CROWN SHEET PLUG

The proper maintenance of the fusible plug where it is applied directly to the crown sheet is generally a difficult matter. The necessity for frequent removal of the plug for inspection and to prevent the accumulation of scale is hard on the threads in the crown sheet and the projection of the plug inside the firebox is burned away by the direct action of the fire.

In order to overcome these difficulties, the type of plug shown in the illustration has been designed and patented by Robert Bonnett, shop foreman of the Hammond Lumber Company, Eureka, Cal., and is in use both on the locomotives and stationary boilers of that company. This fusible plug consists of a brass plug containing the usual fusible metal core, and a steel bushing, the latter being applied to the crown sheet. This bushing when once applied becomes a



Fusible Plug Flush with the Inside of the Crown Sheet

part of the boiler, and remains permanently in the sheet. The brass plug is screwed into the upper end of the steel bushing, which projects into the water space above the crown sheet where the temperature is considerably lower than that of the crown sheet itself. The graphite lubricant applied to the threads of the plug is thus prevented from hardening, and the plug may readily be removed at any time, without injury to the threads. When in place the face of the bushing, the end of the plug and the crown sheet are all flush. A slot is provided in the end of the plug for the application of a thick screw driver, which is used to remove and apply it.

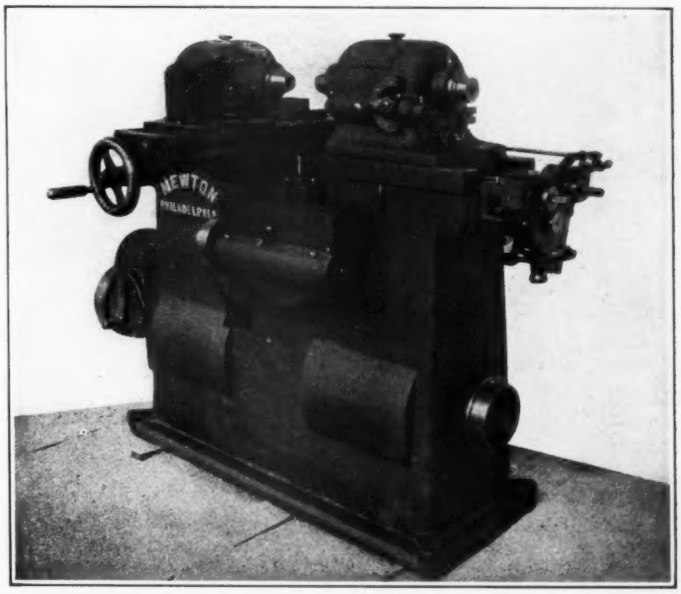
Welding Pipes.—Welded pipes are made by the lap- or butt-weld process, differing, as the terms indicate, in the form of the joint, or weld, extending the length of the pipe. Since a comparatively larger welding surface is obtained by the lap-weld process, it is usually found to be stronger than the butt-weld and as strong at the weld as at any other place. Butt-welding is performed in a manner similar to lap-welding except that the edges of the "skelp" are slightly beveled off at the inside edge, the outside being a little wider than the inside, so that the edges will come squarely together when formed. The weld is usually accomplished by pressing the two edges together while at a welding heat, producing a reduction in the size; or, in other words, the original tube is made oversize and compressed by rolls and rings to the correct diameter and finish. Butt-welding is the practice in making pipe up to about 3 ins. diameter and lap-welding for all larger sizes.—*Power.*

DUPLEX KEYSEAT MILLING AND COTTERING MACHINE

The duplex keyseat milling and cottering machine shown in the engraving has recently been designed by the Newton Machine Tool Works, Incorporated, Philadelphia. This machine increases production and eliminates much of the time ordinarily lost in laying out the work in cases where two keyseats are cut in opposite sides of the same shaft.

The spindles have double taper bearings, are 2 11/16 in. in diameter at the large end of the taper and 1 5/16 in. through the driving section. The spindle heads have automatic feed with safety release for cottering; the maximum feed per stroke of the table is 1/16 in. The spindles have four changes of geared speeds without requiring the removal of the gears, in addition to the back gears on each head, giving a speed range of 300 and 1,465 r.p.m. with eight changes. The single step driving pulley is 10 in. diameter, 2¼ in. face and runs at 735 r.p.m. Drums 12 in. in diameter and 8 in. face are mounted on the driving pulley shaft inside the base, connecting by belt to the spindles on which the back gears are located.

The work table or cross carriage is 44 in. long over all and 38½ in. over finished surface, and is 9 in. wide. It



Duplex Keyseat Milling Machine

has three changes of feed, either continuous for long splines or automatic reversing for cottering. The maximum diameter of the shaft which can be operated on is 4 in. and the speeds and feeds are suitable for keyseats from ⅛ in. to ¾ in. wide, inclusive. The maximum cross feed of the carriage is 24 in. and the height from the table to the center of the spindles is 3½ in. The net weight of the machine is 3,000 lb.

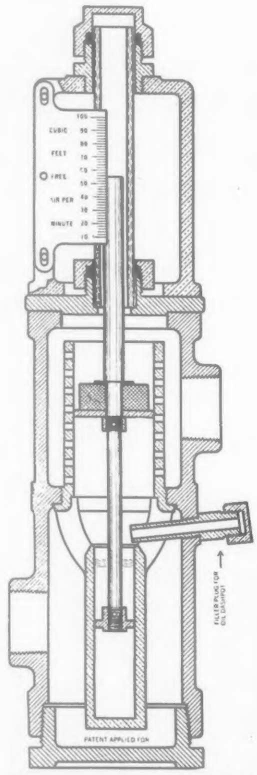
For use in connection with this machine there has been

developed a fixture for this company's slotting machine for cutting both internal keys at one time, thereby assuring an accurate fit of the keys on all sides.

COMPRESSED AIR METER

The illustration shows the Tool-om-eter, which is the one-inch size of compressed air meters, made by the New Jersey Meter Company, Plainfield, N. J. It has a capacity of 10 to 100 cu. ft. of free air per minute and is intended for the measurement of air used by shop pneumatic tools.

The moving element consists of a weighted piston in the upper or metering cylinder, a small piston in the oil dashpot cylinder and a rod joining the two pistons and extending upward where it moves freely, without contact, inside the sight glass at the top of the meter. This rod rises and falls with the pistons so that its height in the sight glass corresponds exactly to the position of the piston in the metering cylinder. The scale plate mounted against the outside of the sight glass permits reading the exact height of the top end of the rod.



Compressed Air Meter

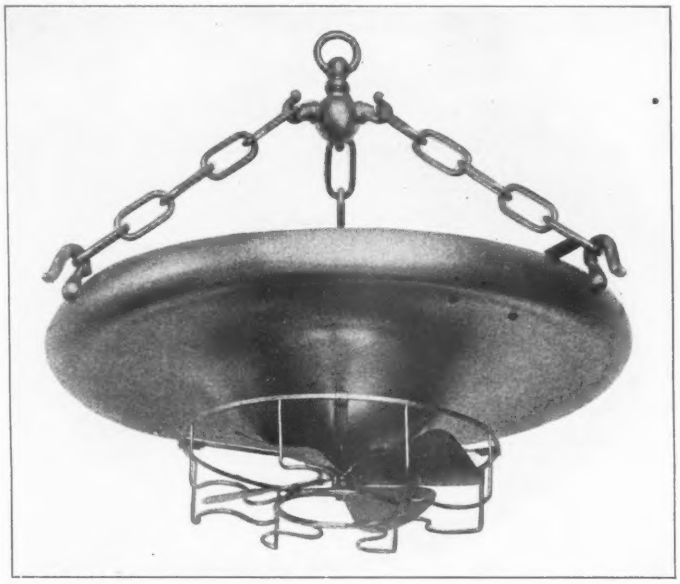
Air enters at the lower left hand opening into the chamber surrounding the dashpot cylinder and passes through ported openings into the interior of the metering cylinder, the wall of which is drilled with a large number of small accurately-reamed holes uniformly spaced (only the holes in the plane of section are shown in the engraving.) To pass to the outlet chamber the air lifts the piston and exposes some of the holes to the flow.

A small "head," or difference of pressure, is established between the interior of the cylinder and the outlet chamber, this pressure difference, only a few ounces per square inch, being fixed by the exact weight of the moving element and the area of the piston on which the difference of pressure acts. The moving element rises until the weight is exactly supported by the difference in pressure; the pistons and rod are then floating in static balance in a position corresponding to the volume of air flowing, the number of holes exposed and the height of the top of the rod in the sight glass. The divisions of the scale plate are calibrated by comparison with a standardized instrument to read correctly. This is not a velocity meter which would give readings proportional to the square of the volume flowing, but is a direct volume gage with a uniform scale on which one cubic foot is represented by the same distance whether working at low or high capacity.

RAIL EXPORTS.—The exports of rails from the United States last year were 391,491 tons, as compared with 174,680 tons in 1914, and 460,553 tons in 1913. The largest shipments last year were to Asia and Oceania. There was a very appreciable falling off in the exports to Canada, Mexico, Japan, and South America. On the other hand, the imports of rails into the United States last year were 78,525 tons, as compared with 22,571 tons in 1914, and 10,408 tons in 1913. The value of last year's imports was $2,088,532, thus giving an average of $26.59 per ton.—*Engineering.*

ELECTRIC CEILING FAN FOR PASSENGER CARS

An indirect acting ceiling fan for use in passenger equipment has been developed by H. C. Hood and is being placed on the market by the Central Electric Company, Chicago.



Indirect Acting Ceiling Fan

In its action it bears a relation to the usual type of ceiling fan similar to that which the indirect lighting fixture bears to the reflector type of fixture. Instead of allowing the draft

Application of the Indirect Fan to a Parlor Car; the Fans Are Placed Two Fixtures Apart

to come direct from the fan to the passengers, the fan blades are reversed, causing the current of air to be directed upwards against the curved surface of a large disk which serves

as a deflector, redirecting the air downward again on all sides of the fan; this air movement, however, is so gentle as not to cause any direct draft downward so that it strikes on the heads of the passengers.

There is a constant movement of air upward immediately below the fan and for an angle of about 45 degrees to the sides. Upon leaving the deflecting surface of the curved disk above the fan blades, the motion of the air is almost horizontal in all directions. This latter movement striking the quarter deck of the cars or the sides of a room, is again deflected downward. The result of this is that there is a gentle air motion which gives a decided effect of coolness in the car or room without a draft, a comparatively large volume of air being affected.

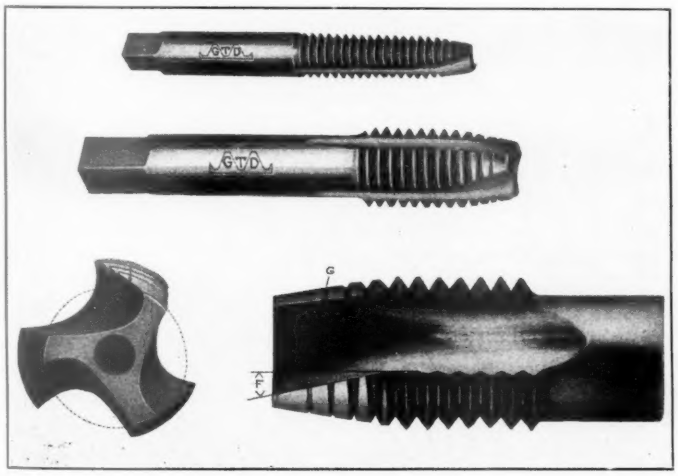
The fan construction is very simple, the blades being simply reversed from the ordinary practice in fan construction so as to draw the air toward the motor instead of away from it; the motor, however, is concealed behind the curved portion of the deflecting disk as shown in the illustration. The curve of this large disk is so designed as to deflect the air at the proper angle and at the same time provide for handling this air with a minimum of resistance, insuring maximum operating efficiency.

The car interior shows how this type of fan may be placed between the lighting fixtures without causing any undue congestion.

THE "GUN" TAP

The "Gun" tap is the name by which this tap has been known during the time that it has been in process of experimentation. It takes its name from the fact that it was originally designed for use in gun work. On account of the tough and wiry material used in this class of work, ordinary taps were very apt to break. The name, however, should not be confusing as this tap is designed for use in all kinds of material and in all classes of shop work, railroad as well as industrial.

Reference to the photograph will show the different construction from the ordinary tap. The cutting edges at the point are ground at an angle to the axis of the tap in order to cut with a shearing action. This throws the chips, unbroken, ahead of the tap instead of allowing them to collect in and clog the flutes. The two or three flute construction is thus possible, and much shallower flutes can be used than are possible in the ordinary tap. It is claimed by the makers, the Greenfield Tap and Die Corporation, Greenfield, Mass., that the tap has almost the strength of solid stock. If the tap should break it will only chip off the sharp cutting edge, which can be easily reground and again placed in a satisfactory condition.

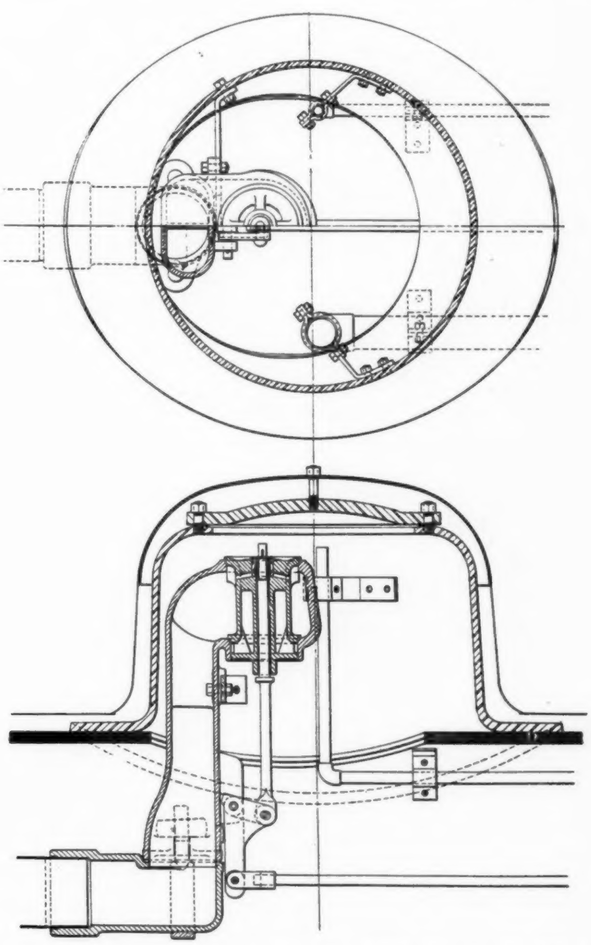


Types and Construction of the "Gun" Tap

This tap does all its cutting on the first few teeth. The rest of the thread on the tap acts as a lead screw, steadying the tap and producing a very accurate thread. It is ground on the angular cutting edge instead of in the flutes as in the ordinary tap, and can be reground repeatedly until there are only three or four full threads left, and will maintain its size to this limit. A simple tap of this type can be used in many places where two and three taps, used successively, have been required, as the free cutting qualities permit working under much more difficult conditions and in much tougher materials than is possible with the ordinary type of tap.

ARRANGEMENT OF THROTTLE AND STANDPIPE

The Baldwin Locomotive Works has recently developed a method of throttle and standpipe application which is shown in the engraving. The standpipe is flattened so as to make the section more oval than circular and the throttle valve can thus be placed closer to the dome. This leaves sufficient space, without enlarging the hole in the boiler, to permit the passing of a man's body without requiring the removal of either the throttle or the standpipe. It will readily be recognized that such an arrangement is of special value in order to reduce the time necessary in carrying out the inspection of boilers to comply with the Interstate Commerce Commission's requirements. On many locomotives not fitted with such an arrangement it is necessary to remove the throttle



Throttle Arrangement Which Permits Easy Access to the Boiler Through the Dome

and stand pipe from the dome before this inspection can be carried out.

PISTON VALVE CHAMBER FOR SLIDE VALVE CYLINDERS

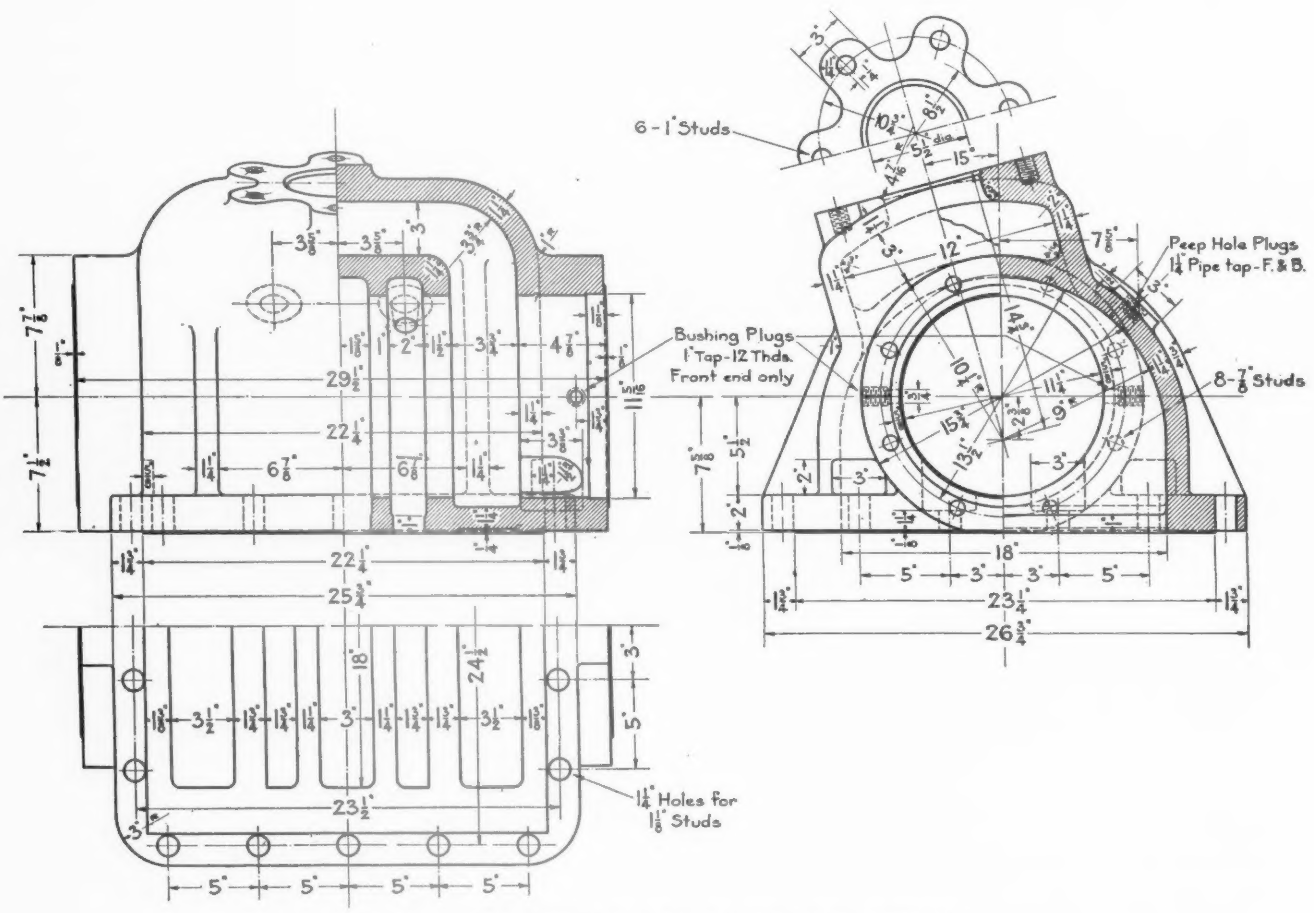
The drawing shows a type of piston valve chamber for application to slide valve cylinders which has recently been placed on the market by the G. F. Cotter Supply Company, Houston, Texas. As shown in the drawing the valve chamber is of a straightforward design, being cast in one piece and fitted to the cylinders in place of the slide valve steam chest. It is fitted with a bushing having ⅝-in. walls, which permits reboring several times before renewal of the bushing is necessary.

The steam chest shown in the drawing is designed for use with outside steam pipes, this type generally being desirable when the locomotive is equipped with a superheater. The smokebox ends of the steam channels in the cylinder saddles are blanked, the valve ends being blanked by the steam chest, and steam is admitted directly through the top of the steam chest. The steam chest is also built for use with the existing steam pipe arrangement generally found on the older locomotives equipped with slide valves. In this case the only work required is the facing of the valve seat, the same stud holes being used and the same valve motion being retained.

The joint between the chest and the seat, is said to easily be kept tight, sufficient stock being provided in the central bridge in chest and bushing to admit the use of a 1-in. stud if desired. Each port is surrounded by a copper wire gasket and special steel holding-downs studs are provided for additional security. The working port area in the case of the 11-in. valve which is used on engines having cylinders up to 22 in. in diameter is 26 in. in length. Peep-holes are provided through the valve chamber walls to facilitate the inspection and the setting of the valves.

The valve spool is a single casting made up of two end rings and a central hub around which is the exhaust cavity. Each of the end rings is fitted with two packing rings of L section.

This steam chest has been in use for several years with both saturated and superheated steam, and it is said to be giving satisfactory service.



A Simple Piston Valve Chamber for Slide Valve Cylinders

BOILER WALL COATING

The H. W. Johns-Manville Company, New York, has recently brought out a stationary boiler wall coating. The desirability for an easily applied coating was realized because of the fact that imperfect combustion, with its corresponding heat loss, is often caused by too much air in firing, and particularly by too much air leaking into the boiler. Each crack in the boiler setting allows air to leak in and mix with the flue gases before perfect combustion takes place; moreover the air which leaks in is cold and uses up heat units which should be developing steam. The result is decreased boiler efficiency.

This product, which is known as J-M Aertite boiler wall coating, is applied to the outside of the boiler wall, and it is claimed that it eliminates air infiltration. It provides a coating over the entire boiler setting which remains tight on account of its adhesive and ductile qualities. It is easily applied by troweling. The best results are obtained by keeping the thickness as near 1/16 in. as possible. The quantity required to cover 100 sq. ft. depends on the number and variety of cracks and the way the wall has been pointed

up. For 1/16 in. thickness it will take approximately 25 to 40 lb. per hundred sq. ft.

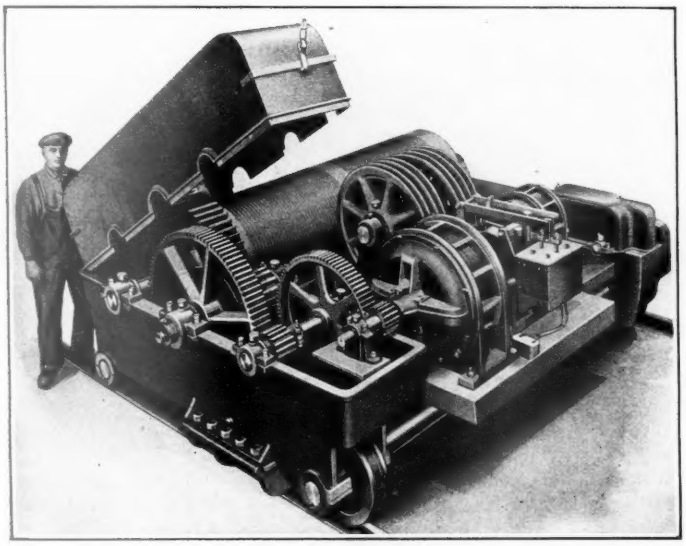
A test was conducted at a large power plant in New York City, with the following results:

	Before Application.	After Application.
Per Cent of CO_2 in flue gases taken from back of first baffle wall	13.5	13.8
Per Cent of CO_2 in flue gases take from back of second baffle wall	11.6	13.5

LOCOMOTIVE CRANE TROLLEY

One of the largest alternating current cranes ever installed for handling locomotives has been furnished recently by the Whiting Foundry Equipment Company, Harvey, Ill., to the Seaboard Air Line for the new shops at Portsmouth, Va. The crane is of 160 tons capacity with two 80-ton trolleys, one of which is equipped with a 10-ton auxiliary hoist.

The trolleys are of the construction shown in the illustration. The entire train of gears is enclosed and runs in an oil bath. The motor pinion has an outboard bearing as shown. The idler sheaves are mounted on a separator, thereby allowing the operator to inspect the rope and oil



Two-Motor Electric Crane Trolley, Capacity 80 Tons

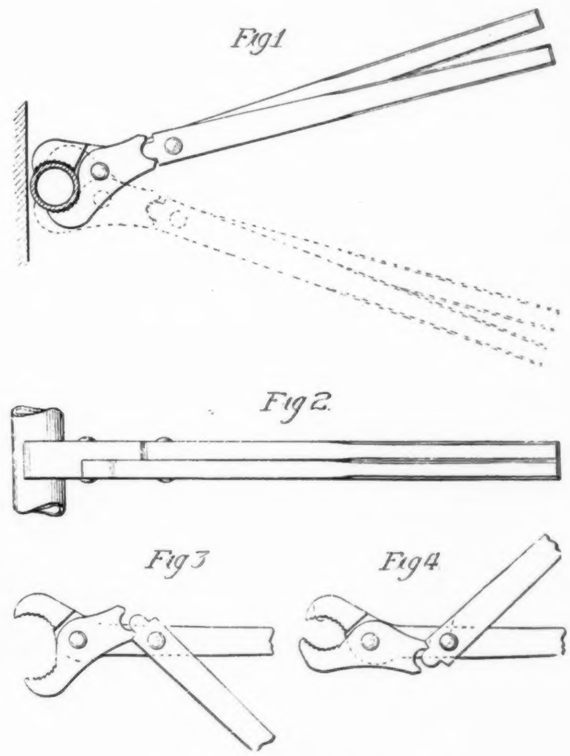
the sheaves while standing on top of the trolley. This also increases the lift of the crane by about 30 in. With the exception of the drum shaft, no shafts extend across the trolley. All shafts in the gear train are on the same line and are cast steel, machine cut. The pinions are forged, as is the drum gear. The trolley sides and separator are cast steel, the housing being of structural steel, provided with proper hand holes to allow for inspection and easy removal for making repairs.

ARKANSAS MANGANESE.—The Arkansas manganese field has been the scene of considerable activity during the last few months in consequence of the rapid advance in the price of ferro-manganese. The deposit is being worked rather crudely by reason of the want at present of concentrating machinery, but the ore, which promises good results from better treatment, is being held for future milling. About 10 cars per week are being despatched, mostly of high-grade ore, yielding in some cases as much as 60 per cent in manganese. The area of the field is 260 square miles.—*Engineering.*

THE LA ROCK PIPE WRENCH

A pipe wrench of special design and particularly fitted for working pipe where the clearances are limited, has recently been placed on the market by the Mechanical Specialty Company, Peoples Gas Building, Chicago. The construction and application of this wrench to a pipe are shown in the drawings.

It will be noticed that the tongs bear on two-thirds of the circumference of the pipe, which can be worked with a wrench motion of 10 degrees. The wrench is of simple construction, being made up of only three parts, with no screws, springs, pins or ratchets. There are no adjustments to be



How the Wrench Operates

made and the wrench is always in position to do the work necessary. It comes in four sizes, there being a special size for the 3/8-in., the 1/2-in., the 3/4-in. and the 1-in. pipe. Although each wrench is especially fitted for its own size of pipe, it will satisfactorily work the next smaller and the next larger size. The wrench is made of high-grade, drop forged steel with special steel rivets, and will stand more strain than can be applied by the man using it.

A BILLION FEET OF LUMBER FROM CALIFORNIA.—A total of more than a billion feet of lumber was sawed by California mills during 1915, according to statistics compiled by the U. S. Forest Service. The report includes figures from 136 mills, thirty-five of which had cut 90 per cent of the total. Of thirteen kinds of wood sawn, redwood led with a total of 418,824,000 ft. b.m. With the exception of about 1,000,000 ft. b.m., it was all California timber.

REMOVING OIL FROM LEATHER BELTING.—Oil can be removed by soaking the belting in baths such as gasoline, for taking up the oil, but the treatment is not recommended unless practiced by expert belt makers, as liquids that dissolve the oil are likely to injure the texture of the leather and loosen the cementing of the laps. In most cases a sufficient quantity of oil can be removed to render the belt serviceable by packing it in dry sawdust for several days.—*Power.*

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WE GUARANTEE, that of this issue 7,600 copies were printed: that of these 7,600 copies, 6,600 were mailed to regular paid subscribers, 102 were provided for counter and news companies' sales, 468 were mailed to advertisers, exchanges and correspondents, and 430 were provided for new subscriptions, samples, copies lost in the mail and office use: that the total copies printed this year to date were 65,200, an average of 8,150 copies a month.

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VOLUME 90 AUGUST, 1916 NUMBER 8

CONTENTS

A fire at the shops of the Seaboard Air Line, at Portsmouth, Va., July 6, destroyed the coach shed and ten passenger cars. The estimated loss was $100,000.

The office of the mechanical superintendent of the Texas & Pacific has been transferred from Marshall, Tex., to Dallas. The jurisdiction of the mechanical superintendent has been extended over the fuel bureau.

FIRST NEW LARGE STEAMER IN UNITED STATES WITH SUPERHEATER

While there are about 1,500 steamers, representing over 2,000,000 hp., sailing from foreign ports equipped with fire tube superheaters, the recent launching of the Pearl Shell at the ship yards of the Harlan & Hollingsworth Corporation, Wilmington, Del., represents the first installation in a new steamer built in this country.

The Pearl Shell is an oil tanker, is to be operated by the Shell Oil Company of San Francisco, and will for the present sail out of New York harbor. It is over 400 ft. long, represents a gross tonnage of over 5,600 tons, and is equipped with three Scotch marine boilers fitted with Locomotive Superheater Company fire tube superheaters, supplying superheated steam to triple expansion engines, developing 2,400 hp.

The superheater was applied to the Pearl Shell after the purchasers had determined the economy and reliability in operation of a superheater of the same design, applied to one of their existing steamers of approximately the same size They have also contracted for sufficient superheater equipment to convert five more of their existing ships.

CARS AND LOCOMOTIVES ORDERED IN JULY

The high prices of materials and the fact that July is always more or less a quiet month from the standpoint of equipment purchasing kept the orders for cars and locomo-

tives during the month at a low figure. The orders for cars and locomotives reported during the month were as follows:

	Locomotives	Freight Cars	Passenger Cars
Domestic	24	2,413	46
Foreign	27	210	..
	51	2,623	46

Among the locomotive orders reported were the following: Duluth, Winnipeg & Pacific, 10 Consolidation locomotives, American Locomotive Company; Philadelphia & Reading, 10 switching locomotives, company shops, and Central of Brazil, 7 Pacific and 12 Ten-wheel locomotives, American Locomotive Company.

The freight car orders included an order placed by the Duluth, Winnipeg & Pacific with the Haskell & Barker Car Company for 750 box cars. The Chicago, Milwaukee & St. Paul will soon build 1,100 42-ft., 40-ton box cars in its Milwaukee shops. The total of 46 passenger cars was almost entirely made up by 42 all-steel elevated car bodies ordered by the Boston Elevated from the Pressed Steel Car Company.

MEETINGS AND CONVENTIONS

Master Blacksmiths' Association.—The twenty-fourth annual convention of the International Railroad Master Blacksmiths' Association will be held at the Hotel Sherman, Chicago, August 15-17, 1916. The following subjects will be discussed: Frame Making and Repairing, Drop Forgings, Tools and Formers, Spring Making and Repairing, Frogs and Crossings, Carbon and High Speed Steels, Case Hardening, Oxy-Acetylene and Electric Welding, Shop Kinks, Heat Treatment of Metals, Piece Work and other Methods, Reclaiming of Scrap Material, Flue Welding.

American Railway Tool Foreman's Association.—The convention of the American Railway Tool Foreman's Association will be held on August 24-26, at the Hotel Sherman, Chicago. The following subjects will be presented by the committees: Heat Treatment of Steel, Henry Otto, chairman; Special Tools for Steel Car Repairs—Devices for Reclaiming Material, J. W. Pike, chairman; Special Tools and Devices for the Forge Shop, G. W. Smith, chairman; Emery Wheels as Applied to Locomotive Repairs, A. Sterner, chairman; Jigs and Devices for Enginehouses, F. D. West, chairman.

International Railway General Foremen's Association.—The twelfth annual convention of the International Railway General Foremen's Association will be held at the Hotel Sherman, Chicago, on August 29 to September 1, and not in July as formerly. The following is the list of topics with the name of the chairman of the committee which is to prepare them: Car Department Problems, E. E. Griest, chairman; Counterbalancing of the Locomotive and Fitting Up of the Frames and Binders, H. C. Warner, chairman; Classification of Repairs, Robert Wilson, chairman; Relation of the Foreman to the Men, T. E. Freeman, chairman.

Master Car & Locomotive Painters' Association.—The next annual convention of the Master Car and Locomotive Painters' Association will be held at Atlantic City, N. J., on September 12-14, 1916. The list of subjects to be presented is as follows: The Initial Treatment and Maintenance of Steel Passenger Equipment Roofs, etc.; Headlinings Painted White or in Very Light Shades—How Should They Be Treated and Should They Be Varnished; Is It Economy to Purchase Paints Made on Railroad Specifications; The Shopping of Passenger Cars for Classified Repairs; Railway Legislation and Its Effect on Business. The following questions will also be discussed: To what extent is it necessary to remove trimmings from passenger car equipment undergoing paint shop treatment? How does the hot water and oil method of cleaning locomotives at roundhouses affect the painted parts? Is there any advantage in painting or oiling the interior of new or old steel gondola and hopper cars? Is there anything superior to varnish remover for removing paint from a steel passenger car, considering labor and material costs? Is there anything superior to soap for the cleaning of passenger equipment cars preparatory to painting and varnishing?

Traveling Engineers' Association.—The twenty-fourth annual convention of the Traveling Engineers' Association will be held at the Hotel Sherman, Chicago, commencing September 5, 1916, and continuing four days.

A brief program of the meeting follows:

Tuesday, September 5. Morning session, 10:30 a. m.—Opening exercises and consideration of subject: "What effect does the mechanical placing of fuel in fireboxes and lubricating of locomotives have on the cost of operation?" W. L. Robinson (B. & O.), chairman. Afternoon session, 1:30 p. m.—Continuation of the same subject.

Wednesday, September 6. Morning session, 9 a. m.—"The advantages of superheaters, brick arches and other modern appliances on large engines, especially those of the Mallet type." J. E. Ingling (Erie), chairman. Afternoon session, 1:30 p. m.—Committee on subjects for discussion at the 1917 meeting. B. J. Feeny (I. C.), chairman. Evening—The entire evening will be devoted to studying and examining the exhibits.

Thursday, September 7. Morning session, 9 a. m.—"Difficulties accompanying the prevention of dense black smoke and its relation to cost of fuel and locomotive repairs." Martin Whelan (C. C. C. & St. L.), chairman. Afternoon session, 1:30 p. m.—"Recommended practice in the makeup and handling of modern freight trains on both level and steep grades, to avoid damage to draft rigging." L. R. Pyle (Soo Line), chairman.

Friday, September 8. Morning session, 9 a. m.—"Assignment of power from standpoint of efficient service and economy in fuel maintenance." P. O. Wood (St. L. & S. F.), chairman. Afternoon session, 1:30 p. m.—"Standing committee on revision of progressive examinations for firemen for promotion and new men for employment." W. H. Corbett (M. C.), chairman. Committee report on change of constitution and by-laws. J. C. Petty (N. C. & St. L.), chairman. Election of officers. Adjournment.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Master Mechanics' Association.—J. W. Taylor, Karpen Building, Chicago.

American Railway Tool Foremen's Association.—Owen D. Kinsey, Illinois Central, Chicago. Convention, August 24-26, 1916.

American Society for Testing Materials.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. R. McMunn, New York Central, Albany, N. Y. Convention, October 3-5, Indianapolis, Ind.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio. Convention, August 15-17, 1916, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 547 W. Jackson Blvd., Chicago. Convention May, 1917, Chicago.

International Railway General Foremen's Association.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, August 29-Sept. 1, 1916, Hotel Sherman, Chicago.

Master Boiler Makers' Association.—Harry D. Vought, 95 Liberty St., New York.

Master Car Builders' Association.—J. W. Taylor, Karpen Building, Chicago.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass. Convention, September 12-14, 1916, "The Breakers," Atlantic City, N. J.

Niagara Frontier Car Men's Association.—E. N. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September 5-8, 1916, Hotel Sherman, Chicago.

PERSONAL

GENERAL

DAN G. CUNNINGHAM has been appointed superintendent of motive power of the Denver & Salt Lake at Denver, Colo. Mr. Cunningham was born at Roanoke, Va., on April 19, 1873, and was educated in the public schools of his native city, and at the Virginia Polytechnic Institute, graduating from the latter institution in 1898. He entered railway service in 1890 as a machinist apprentice in the Roanoke shop of the Norfolk & Western. From 1898 to June, 1900, he was employed as a machinist in the same place. He then entered the service of the Atchison, Topeka & Santa Fe as general foreman at Needles, Cal., returning to the Norfolk & Western in 1904, as roundhouse foreman at Portsmouth, Ohio. From 1907 to March 10, 1912, he was general foreman of the same road at Williamson, W. Va. From March 20, 1912, to June 30, 1916, he was superintendent of shops of the Denver & Rio Grande at Salt Lake City, Utah, which position he held at the time of his recent appointment as noted above.

D. G. Cunningham

ELIOT SUMNER, who has been appointed superintendent of motive power of the Pennsylvania Railroad, with headquarters at Williamsport, Pa., as was announced in the July *Railway Mechanical Engineer*, was born on October 18, 1873, at New Haven, Conn. He attended Yale University, and in 1896 entered the service of the Pennsylvania Railroad as an apprentice at the Altoona (Pa.) machine shop. In February, 1901, he was appointed inspector on the Philadelphia division, and the following October was made assistant master mechanic of the Middle and Western divisions. He was promoted in 1902 to assistant engineer of motive power on the Buffalo and Allegheny Valley division, and the following year was transferred to the office of the general superintendent of motive power. In 1907, he was appointed master mechanic on the Baltimore division, and in 1911 was transferred in the same capacity to the Williamsport division. On December 1, 1913, he was appointed master mechanic at the west Philadelphia shops, which position he held at the time of his recent appointment as superintendent of motive power of the same road at Williamsport, as above noted.

E. Sumner

A. J. WAGAR, chemist of the Buffalo, Rochester & Pittsburgh, has been appointed chemist of the Louisville & Nashville at Louisville, Ky.

F. W. WILSON, formerly road foreman of equipment of the Chicago, Rock Island & Pacific at Rock Island, Ill., has been appointed engineer of fuel economy at Chicago, succeeding H. Clewer, promoted.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

H. CLEWER, engineer of fuel economy of the Chicago, Rock Island & Pacific at Chicago, has been appointed master mechanic of the Missouri division, with office at Trenton, Mo., succeeding E. J. Harris, resigned.

CHARLES W. EXTRAND has been appointed acting road foreman of engines of the Northern Pacific, with headquarters at Northtown, Minn.

WILLIAM F. HEISER, master mechanic of the Chicago & Eastern Illinois, has been transferred to Danville, Ill., succeeding W. R. Meeder, transferred.

W. H. KELLER, general foreman of shops of the Texas & Pacific, at Fort Worth, Tex., has been appointed master mechanic of the eastern division at Marshall, Tex., with jurisdiction extending over the shops at Texarkana, Tex.

WILLIAM R. MEEDER, master mechanic of the Chicago & Eastern Illinois at Danville, Ill., has been transferred to Villa Grove, succeeding R. N. Kincaid, resigned.

JOHN F. MULLEN has been appointed assistant master mechanic of the Buffalo, Rochester & Pittsburgh at Buffalo Creek, N. Y. Mr. Mullen was born at Oswego, N. Y., and after graduating from the Oswego High School took a business course in Oswego College. He entered railway work as a machinist with the Delaware, Lackawanna & Western, later going to the Rome, Watertown & Ogdensburg (now a part of the New York Central) as stenographer and timekeeper. In 1890 he entered the service of the Buffalo, Rochester & Pittsburgh as machinist, and was later made gang foreman. He was the first gang foreman appointed at the general shops at Dubois, Pa., and in 1905 was made general foreman at Buffalo, N. Y., which position he held at the time of his present appointment as assistant master mechanic.

H. G. REID, heretofore master mechanic of the Saskatchewan division of the Canadian Pacific at Moose Jaw, has been appointed master mechanic, District 3, of the National Transcontinental at Transcona, Man., succeeding J. Birse, transferred.

D. W. ST. CLAIR has been appointed master mechanic of the Missouri, Oklahoma & Gulf of Texas at Denison, Tex., succeeding J. R. Greiner, resigned.

A. W. STANDIFORD, general foreman of the Chicago & Eastern Illinois at Salem, Ill., has been appointed master mechanic at Evansville, Ind., succeeding W. F. Heiser.

A. WEST has been appointed district master mechanic, District 4, Canadian Pacific at Edmonton, Alta., succeeding A. J. Ironsides, transferred.

CAR DEPARTMENT

W. J. ALLEN has been appointed leading painter of the Canadian Pacific at West Toronto, succeeding T. Marshall, transferred to Angus shops, Montreal.

M. D. JORDAN, formerly in the car department of the Canadian Pacific at Vancouver, B. C., has been appointed car foreman at Field, B. C., succeeding C. J. Crozier, transferred.

C. A. MUNRO, formerly car foreman of the Grand Trunk Pacific at Melville, Sask., has been appointed car foreman at Edmonton, Alta., succeeding W. Silverwood, transferred.

H. Reid has been appointed car foreman of the Grand Trunk Pacific at Rivers, Man.

W. Silverwood, formerly car foreman of the Grand Trunk Pacific at Edmonton, Alta., has been appointed car foreman at Melville, Sask., succeeding C. A. Munro, transferred.

W. S. Stillwell has been appointed car foreman of the National Transcontinental at Graham, Ont., succeeding G. E. Decker, resigned.

G. W. Wilson has been appointed car foreman of the Grand Trunk Pacific at McBride, B. C., succeeding C. McKinnon, who has enlisted.

SHOP AND ENGINE HOUSE

F. W. Behan, formerly erecting shop foreman of the Grand Trunk Pacific at Transcona, Man., has been appointed locomotive foreman at Regina, Sask.

J. Dodd has been appointed assistant locomotive foreman of the Canadian Pacific at Lambton, Ont., succeeding J. Tregaskis, promoted.

E. J. Harris, master mechanic of the Chicago, Rock Island & Pacific at Trenton, Mo., has been appointed shop superintendent of the Denver & Rio Grande, at Salt Lake City, Utah, succeeding D. G. Cunningham, resigned.

G. C. Hearts, formerly erecting shop foreman of the Canadian Northern at Trenton, Ont., has been appointed locomotive foreman at Toronto, succeeding S. L. Tracey.

Edward F. Houghton has been promoted to superintendent of shops of the Buffalo, Rochester & Pittsburgh at East Salamanca, N. Y., succeeding J. F. Mullen, promoted.

James Medland has been promoted to foreman of the Buffalo, Rochester & Pittsburgh at Clarion Junction, Pa., succeeding E. F. Houghton.

D. E. Smith, formerly locomotive foreman of the Grand Trunk Pacific at Regina, Sask., has been appointed locomotive foreman at Prince Rupert, B. C.

J. Tregaskis, formerly assistant locomotive foreman of the Canadian Pacific at Lambton, Ont., has been appointed night locomotive foreman there, succeeding S. Illingsworth, transferred.

PURCHASING AND STOREKEEPING

R. H. Adams has been appointed assistant purchasing agent of the San Pedro, Los Angeles & Salt Lake at Los Angeles, Cal.

G. E. Cotton has been appointed storekeeper of the Cincinnati, Hamilton & Dayton at Ivorydale, Ohio.

G. T. Ingold has been appointed storekeeper of the Baltimore & Ohio lines at New Castle Junction, Pa.

J. C. McCaughan has been appointed storekeeper of the Baltimore & Ohio at Glenwood, Pa., succeeding O. V. McQuilkin, promoted.

O. V. McQuilkin, storekeeper of the Baltimore & Ohio at Glenwood, Pa., has been appointed district storekeeper, succeeding L. H. Tutwiler, transferred to the accounting department.

William G. O'Fallon has been appointed purchasing agent of the Terminal Railroad Association of St. Louis, succeeding J. E. Williams, Jr.

Isaac B. Thomas, who has been appointed assistant purchasing agent of the Pennsylvania Railroad, with office at Philadelphia, Pa., as was announced in the July *Railway Mechanical Engineer,* was born on June 26, 1872, at West Chester, Pa., and was educated at Friends' High School and at Haverford Grammar School. He graduated from Sheffield Scientific School, Yale University, in 1892, and later in the same year entered the service of the Pennsylvania Railroad as an apprentice at the Altoona (Pa.) shops. In August, 1897, he was appointed inspector of the same shops, and in April, 1899, became inspector in the office of the assistant engineer of motive power of the same road at Altoona. He was appointed assistant master mechanic at Renovo, Pa., in February, 1900, and in October, 1901, became assistant engineer of motive power at Altoona. He remained in that position until August, 1903, when he became master mechanic at Pittsburgh, and was transferred as master mechanic in February, 1906, to the Altoona machine shops. On May 1, 1911, he was promoted to superintendent of motive power of the Erie division (now the Central division) of the same road, and of the Northern Central at Williamsport, Pa., which position he held at the time of his recent appointment as assistant purchasing agent of the Pennsylvania Railroad, as above noted.

OBITUARY

C. L. Bundy, general foreman passenger car repairs of the Delaware, Lackawanna & Western at Kingsland, N. J., died of heart failure on July 2, 1916. Mr. Bundy began his business career at the age of 19 with the Missouri Car & Foundry Company at St. Louis, Mo., and later went to the United States Rolling Stock Company (now a part of the Western Steel Car & Foundry Company) at Hegewisch, Ill. He then entered the railroad field, taking charge of the division shops of the Chicago, Rock Island & Pacific at Trenton, Mo. He was made general foreman of the shops at Davenport, Iowa, and in 1897 was appointed traveling general foreman of the entire car department at Chicago, Ill. He left this position to take charge of the mechanical department of the Swift Refrigerator Line and after two years in this position he went with the Delaware, Lackawanna & Western at Dover, N. J. He then went to the Colorado Southern as general foreman at Denver, Colo. After a few months he returned to the Delaware, Lackawanna & Western as general foreman of shops at Keyser Valley, Scranton, Pa., which position he resigned to accept service with the Hicks Locomotive & Car Works as superintendent of the coach department. In 1908 he again returned to the Delaware, Lackawanna & Western as general foreman, passenger car repairs, at Kingsland, N. J.

A. J. Cota, division master mechanic of the Chicago, Burlington & Quincy, lines east of the Missouri river, with office at Chicago, died at his home in La Grange, Ill., on July 9.

Thomas J. Hutchinson, formerly master car painter of the Grand Trunk at London, Ont., and past president of the Master Car and Locomotive Painters' Association, died June 10, at his home in London, Ont. Mr. Hutchinson had been in the railway painting trade since 1887, being in the employ of the Grand Trunk for all but about three years from that time to the time of his retirement, May 1, 1914. He was a veteran of the Civil war.

Thomas E. Lewis, locomotive inspector of the Norfolk & Western, died on July 16, at the home of his brother, W. H. Lewis, superintendent of motive power of the same road, at Roanoke, Va. He was born on January 11, 1836, in Devonshire, England, and in 1857 entered the service of the New York Central as machinist and foreman at Syracuse, N. Y. He subsequently served as master mechanic on the Hannibal & St. Joseph, and on the Union Pacific. He was superintendent and master mechanic of the Kansas City Elevated Railway and then was master mechanic on the Kansas City, Wyandotte & Western. In 1898 he was appointed inspector of locomotives on the Norfolk & Western.

Fred H. White, purchasing agent of the Duluth, Missabe & Northern, died on July 17, at Duluth, Minn., following a two weeks' illness after an operation for carbuncles.

Supply Trade Notes

The International Oxygen Company, New York, is installing a new plant at College Point, L. I., for the manufacture of oxygen and hydrogen gas.

Henry Alden Sherwin, chairman of the board of directors of the Sherwin-Williams Company, died of heart failure on June 26, at his country place, near Cleveland, Ohio.

R. N. Kincaid, formerly master mechanic of the Chicago & Eastern Illinois at Villa Grove, Ill., has become associated with the Buick Automobile Company at Flint, Mich.

M. T. Kirschke, sales representative of the Baldwin Locomotive Works, with headquarters at Chicago, Ill., died at his home in that city on July 18, after an illness of several weeks.

W. G. Cook, who was recently appointed assistant to the general sales manager of the Garlock Packing Company, has been appointed manager of the Chicago branch of the company.

Willard Wilson, assistant manager of sales of the Tennessee Coal, Iron & Railroad Company, has been appointed general manager of sales of the company, succeeding F. A. Burr, who has left the company to become general manager of sales of the Aetna Explosives Company.

R. J. Himmelright, assistant to the manager of the service department of the American Arch Company, has been appointed manager of that department, succeeding J. T. Anthony, promoted. Mr. Himmelright was born in Barberton, Ohio, in 1883. After completing the common and high school courses there, he took a summer course of two years at Kentucky State University. In 1904 he entered the employ of the Stirling Boiler Company. One year later he entered Purdue University, and graduated in the class of 1909 with the degree of mechanical engineer. He immediately entered the service of the Lake Shore & Michigan Southern as special apprentice, and after serving two years in this capacity was employed by the Locomotive Stoker Company as mechanical expert. This position he held until 1913, when he entered the service of the American Arch Company as traveling engineer. In 1915 he was made assistant to the manager of the service department.

R. J. Himmelright

W. H. Ivers, formerly with the Baldwin Locomotive Works, has been appointed southwestern representative of the Gold Car Heating & Lighting Company, New York, with headquarters at St. Louis, Mo., succeeding George F. Ivers, who has resigned to become manager of the railway supply department of the Shapleigh Hardware Company, St. Louis, Mo.

The Goodyear Tire & Rubber Company, Akron, Ohio, has presented to Battery B, Ohio Field Artillery, stationed at Akron, a fully equipped military kite balloon, which is the first of its kind ever owned by the national guard of any state. The balloon is similar to the one recently delivered to the United States Navy for use at the naval aeronautic station at Pensacola, Fla. It was designed and made entirely in the Goodyear factory. The Goodyear Tire & Rubber Company recently sent an aeronautic expert abroad to make a scientific study of kite balloon development to be better able to assist the United States government in building up its aeronautic service.

J. T. Anthony, manager of the service department of the American Arch Company, New York, has been appointed assistant to the president. Mr. Anthony was born in February, 1883. After completing a common and high school course, he entered the Georgia School of Technology, from which he graduated in 1902. He was then engaged in the textile manufacturing business for four years, but in 1906 entered railway service in the roadway department of the Atlantic Coast Line. He remained with that road until 1907, when he became a draftsman in the motive power department of the Central of Georgia. In January, 1912, he entered the employ of the American Arch Company as combustion engineer. In March, 1914, he was made assistant general eastern sales manager. A few months later he was made manager of the service department, in direct charge of traveling engineers and the supervising of all road work. It is this position he leaves to take up his new duties as assistant to the president.

J. T. Anthony

Oscar F. Ostby, until recently general sales agent of the Commercial Acetylene Railway Light & Signal Company, has been appointed general manager of the Refrigerator, Heater & Ventilator Car Company, St. Paul, Minn. Mr. Ostby is very well known in the railway supply field. He has been particularly active in the work of the Railway Supply Manufacturer's Association, having been vice-president of the association in 1914-1915, and its president in the year just ended. He has also been active in the International Acetylene Association, having been a director and vice-president and in 1909-1910 its president. As the chairman of the association's legislative committee, he led the fight against the passage in several states of headlight laws requiring the use of electric equipment only. He was born March 5, 1883, and received his education in the public schools of Providence, R. I. From 1901 to November, 1904, he engaged in publicity work. He then entered the service of what was later the Commercial Acetylene Railway Light & Signal Company, and at the time of his resignation on June 1 of this year was the general sales manager of the company.

O. F. Ostby

CATALOGUES

Oil Engines.—The National Transit Pump & Machine Company, Oil City, Pa., in Bulletin No. 502 describes the National Transit, 4-cycle Diesel oil engine, type DH4A.

Turret Lathes.—One of the recent publications of the International Machine Tool Company, Indianapolis, Ind., deals with the "Libby" heavy duty turret lathe in railroad shops. The booklet contains illustrations of the lathes, and gives operating records dealing with their work in railroad shops.

Locomotive Appliances.—The G. F. Cotter Supply Company, Houston, Tex., general sales agents for the Simplified Steam Chest Company of the same city, has issued a folder relative to the simplified piston valve steam chest for supplying slide valve locomotives with piston valves for use with superheated steam.

Locomotive Cranes.—The Brown Hoisting Machinery Company, Cleveland, Ohio, has just issued a booklet of 64 pages, which describes in detail its locomotive cranes and the various attachments which may be added for special uses. The book is illustrated with over 125 photographs showing this type of equipment engaged in a wide variety of operations.

Bumping Posts.—The Railway and Traction Supply Company, Chicago, has issued a 56-page catalog illustrating installations of the Hercules steel bumping post, the Little Giant bumping post, the Weatherson nut lock and the Wyoming vacuum track sander. One interesting feature is the account of the special Hercules bumping posts installed on the Panama canal locks for the towing locomotives.

Generator Cooling and Cleaning.—This is the title of a booklet which has been recently issued by the Carrier Air Conditioning Company, Buffalo. It describes the Carrier Generator Cooler, and the advantages to be gained by cooling and cleaning the air supply for ventilation of turbo generators. The booklet is illustrated, and special attention is paid to a description of the non-clodding type of spray nozzles.

Pressed Steel Construction.—The Trussed Concrete Steel Company, Youngstown, Ohio, has issued a 24-page booklet, describing the Kahn pressed steel joists and studs with Hy-rib for floors, roofs, walls and partitions. This book describes in detail and illustrates the methods of construction for which this material is adapted. It also contains a number of photographs of installations and of methods of application.

Pyrometers.—The Gibb Instrument Company, Pittsburgh, Pa., has issued a folder relative to the "I-Rite" pyrometer for judging the temperature of metal undergoing treatment. The "I-Rite" is an instrument in appearance much like a pocket flashlight. The person using it stands some distance from the furnace, and looks through it at the object whose temperature is to be determined. A description of it appeared in the May, 1916, *Railway Mechanical Engineer,* page 262.

Train Control.—The Miller Train Control Corporation, Staunton, Va., has published a 16-page booklet entitled, "Miller Train Control," which includes a brief resumé of the development of this device, a description of its operation, a record of its installation and the service which it is rendering on the Chicago & Eastern Illinois and a brief comment on the place of the automatic stop in modern railway operation. The booklet is handsomely bound in black leather and artistically illustrated.

Storage Batteries.—The Edison Storage Battery Company has prepared a new booklet on its storage battery, and this was distributed the first day of the M. C. B. convention. This booklet is considerably more elaborate than any issued in the past. It is profusely illustrated, and contains a simple and concise explanation of the chemical action taking place in the Edison battery on charge and discharge. It also gives complete data on train lighting batteries, which will be of interest to railroad officers.

Graphite for Cylinder Lubrication.—A booklet recently issued by the Joseph Dixon Crucible Company, Jersey City, N. J., bears the title of "Graphite for Cylinder Lubrication." The booklet tells of graphite lubrication for both steam and gas cylinders and gives facts about lubricators made by various companies to use graphite alone or with oil. Data is given also concerning the saving possible with graphite lubrication, a saving of 50 per cent being asserted as possible with the proper use of flake graphite lubrication.

Steam Hammers.—The National Hoisting Engine Company, Harrison, N. J., has issued a 20-page catalogue describing the National steam pile hammer. The booklet contains tables giving the dimensions and other characteristics of the five sizes of these hammers and is illustrated with photographs showing the hammers in use on various kinds of construction work. A 12-page pamphlet has also been issued describing the steam hammers No. 6 and No. 7, weighing 650 and 150 lb. respectively, which are designed especially for use in driving wood and steel sheet piling.

Pulverized Fuel.—Bulletin 1 of the Locomotive Pulverized Fuel Company, New York, bears the title Pulverized Fuel for Locomotives. On the first page is shown an illustration of the Delaware & Hudson Consolidation locomotive equipped for burning pulverized coal which was exhibited at the Atlantic City conventions. The various sections of the bulletin deal respectively with the following subjects: specification for pulverized fuel; combustion of pulverized fuel; the locomotive fuel bill; advantages to be obtained by the use of pulverized fuel in locomotives, etc.

The History of the Planer.—This is the title of an attractive booklet which has recently been issued by the Cincinnati Planer Company, Cincinnati, Ohio. The booklet is a study of contrasts, there being shown on facing pages examples of the early and earliest planers and examples of the modern planers now forming part of the company's line. The latter part of the booklet also compares machines made by the Cincinnati Planer Company in its earlier days with the same class of machines which it now makes, the accompanying reading matter explaining wherein the most important improvements have been made.

Coal and Ashes Gates.—C. W. Hunt Company, Inc., West New Brighton, N. Y., has recently issued catalogue No. 15-3 relative to the Hunt coal and ashes gates. The catalogue is of the standard 6 in. by 9 in. size. It contains illustrations and complete descriptions of the company's standard types of gates or valves for controlling the flow of bulk materials. The dimensions are given of those which are more frequently used in power house and storage pocket design. The illustrations showing the application of these valves are selected with the idea of assisting where there is any question as to the type best suited to the requirements.

Potentiometer System of Pyrometry.—This is the title of a booklet recently issued by the Leeds & Northrop Company, Philadelphia. The potentiometer pyrometer is based upon the use of the thermocouple, but differs from the ordinary deflection galvanometer or millivoltmeter pyrometer in that the electromotive force resulting from the difference in temperature between the hot and cold ends of the thermocouple is measured by a novel balancing method rather than by a deflecting galvanometer. The potentiometers employed are of two general types, hand adjusted indicators and automatically adjusted recorders. The recorders are of the single-point curve-drawing class and of the multiple-point

printing class, the latter being supplied for keeping records of the temperatures of as many as 16 different thermocouples.

ENGINE INDICATORS.—The Trill Indicator Company, Corry, Pa., has issued a new 56-page booklet on engine indicators and indicating. The construction and purpose of the several parts of both the outside and enclosed spring types of indicators, including indicator reducing motion, are described in detail and well illustrated. Detailed instructions are given on the application and use of the indicator and the planimeter. There are 15 pages illustrating and discussing the characteristic diagrams of the several types of engines including the new Poppet valve type, the Uniflow engine, the high compression two cylinder oil engine and the Diesel engine.

AIR COMPRESSORS.—The Ingersoll-Rand Company has issued two new bulletins describing recent designs of air compressors. Form No. 3026 describes the Ingersoll-Rogler Class "Pre" Air Compressor, which is designed for high speed to permit the use of the moderate priced motors obtainable where high speed can be used. This has necessitated the use of special provisions in the way of lubrication and valves which are efficient at high speed. Form No. 3312 describes the "Imperial XB2" Two Stage Air Compressor, which is an all around machine of moderate cost. The bulletins are amply illustrated and describe the features of the machines in detail.

HOPPER DOOR MECHANISM.—The United States Metal & Manufacturing Company, New York, has recently issued a folder descriptive of the Dunham hopper door device. The Dunham mechanism gives a positive lock. In locking, the oscillating point or upper link pin of the shaft arm passes beyond the pivotal point or point of support of the shaft arms, the door connecting links resting on a stop when the oscillating point has reached a given distance beyond the pivotal center. The resultant pull is hence below or beyond the point of support, and the greater the load applied to the doors the more positive the lock. The folder has half-tone and line illustrations showing the mechanism applied to gondola and self-clearing hopper cars.

OIL FILTERS.—Bulletin No. 5, bearing the title of "Oil Filters," recently issued by the Richardson-Phenix Company, Milwaukee, Wis., describes a complete line of filters for purifying lubricating oil, having capacities of from 25 gallons per day to 50,000 gallons per hour. The catalog is very complete and describes some interesting large size filters for use in purifying lubricating oil from water wheel thrust bearings, large gas and steam engines in steel mills and also for purifying cutting lubricants. The catalog also serves to indicate the advance made in recent years in the science of oil filtration and shows how scientific principles are employed in the small as well as the large size filters. The large filters are made of heavy steel plate, the oil connections into some of them being for 10 in. pipe.

DU PONT PRODUCTS.—The Du Pont companies have recently issued a 111 page book, 5 in. by 8 in. in size, giving a complete list of the products made by E. I. Du Pont de Nemours & Co., the Du Pont Fabrikoid Company, the Du Pont Chemical Company and the Arlington Company. The book contains list of products arranged under the following heads: high explosives; low explosives; black blasting powder; sporting powders; explosives for military uses; miscellaneous commodities; blasting supplies; Fabrikoid; chemicals; Pyralin; special products and by-products. In each case a brief description of the commodity is given, followed by a list of its users and also its uses. In a section headed customers, are given the names of all kinds of users alphabetically arranged followed in each case by a list of commodities available for that particular industry. The book itself is bound in Fabrikoid.

CAR WHEELS.—The American Steel Foundries have issued an attractive catalogue descriptive of the Davis steel wheels made by the company. The booklet names the advantages of the Davis one-wear steel wheel asserting that, "It retains the advantages of the cast iron wheel—a hardened tread and flange, a softer plate and hub, and a one-wear construction" and in addition is stronger, is of less weight, has absolute rotundity because of its ground treads and has a lower maintenance cost on account of fewer removals for common wheel defects. The booklet is well illustrated, there being given sections, pictures of the wheels, and a number of views, some in colors, showing the manufacture. One section deals with wheels for electric railway service and another gives comparative data of Davis and other wheels.

TELEPHONE APPARATUS.—The Western Electric Company has recently issued Catalogue No. 3 of telephone apparatus and supplies containing in its 400 pages illustrations, descriptions, specifications and list prices of its complete line of telephones and accessories. The listings include everything that is needed by telephone companies for the inside and outside plant—telephones, switchboards, power plants, cable, line construction tools, line construction materials and miscellaneous telephone apparatus. The listings include all types of equipment that are in common use. The book contains, further, complete descriptions, circuit diagrams and directions for use. The Western Electric Company has also lately issued the section of the catalogue dealing with interphones in a separate 60-page catalogue bearing the title: Western Electric Interphones and Accessories.

HEAT INSULATION FOR STEAM LINES AND BOILERS.—The Armstrong Cork & Insulation Company, Pittsburgh, Pa., has recently issued an 84 page book, entitled Nonpareil High Pressure Covering for Heated Surfaces, treating in great detail of the subject of insulation for high pressure and superheated steam lines. The first few pages of the book consider the requirements for this kind of insulation. Pages 7 to 21 are devoted to a series of comparative tests made at the company's Beaver Falls factory. As a result of these tests the company has been able to fix definitely the heat losses from various sizes of pipe, both covered and uncovered. These losses are given in B. t. u. units per lineal foot, per degree difference in temperature for 24 hours, and are tabulated on pages 41 and 42. On page 45, there are also given tables which show, in a general way, the most economical thicknesses of Nonpareil high pressure covering to use, based on different steam costs. A complete set of specifications, covering the correct installation of these various thicknesses of covering, is given on pages 65 to 78. The book is well bound in board and is well illustrated with half tones and line drawings.

AIR COMPRESSORS, WATER DRILLS, ETC.—The Ingersoll-Rand Company, New York, has recently issued three bulletins, designated respectively, Forms 3036, 3029 and 4120. Form 3036 deals with turbo blowers. These blowers are suitable for any air service where the capacity requirements range from 3,000 to 35,000 cu. ft. of free air per minute at pressures of 1 to 2½ lb., and are particularly adapted for such work as foundry cupola blowing; atomizing oil for oil burners; supplying blast to various kinds of heating and annealing furnaces; blowing air for water gas generators; pneumatic conveying systems and for ventilating purposes. Form 3029 describes the "Ingersoll-Rogler" Class "ORC" Corliss steam driven air compressors of the duplex type, with the steam cylinders next to the frames and separated from the air cylinders by open distance pieces. This type of machine is offered in four different combinations of cylinders. The catalogue gives sizes and capacities. Form 4120 describes the Leyner-Ingersoll water drills of both the No. 18 and No. 26 type. It explains the construction in detail, and illustrates the different types.